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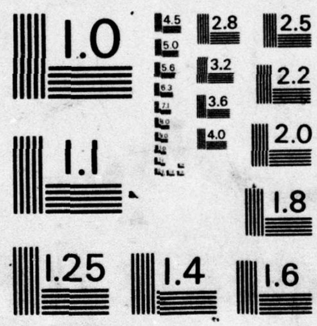

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REPORT OF TEST

USATECOM PROJECT NO. 4-3-3171-01

MILITARY POTENTIAL TEST OF THE UH-2A HELICOPTER

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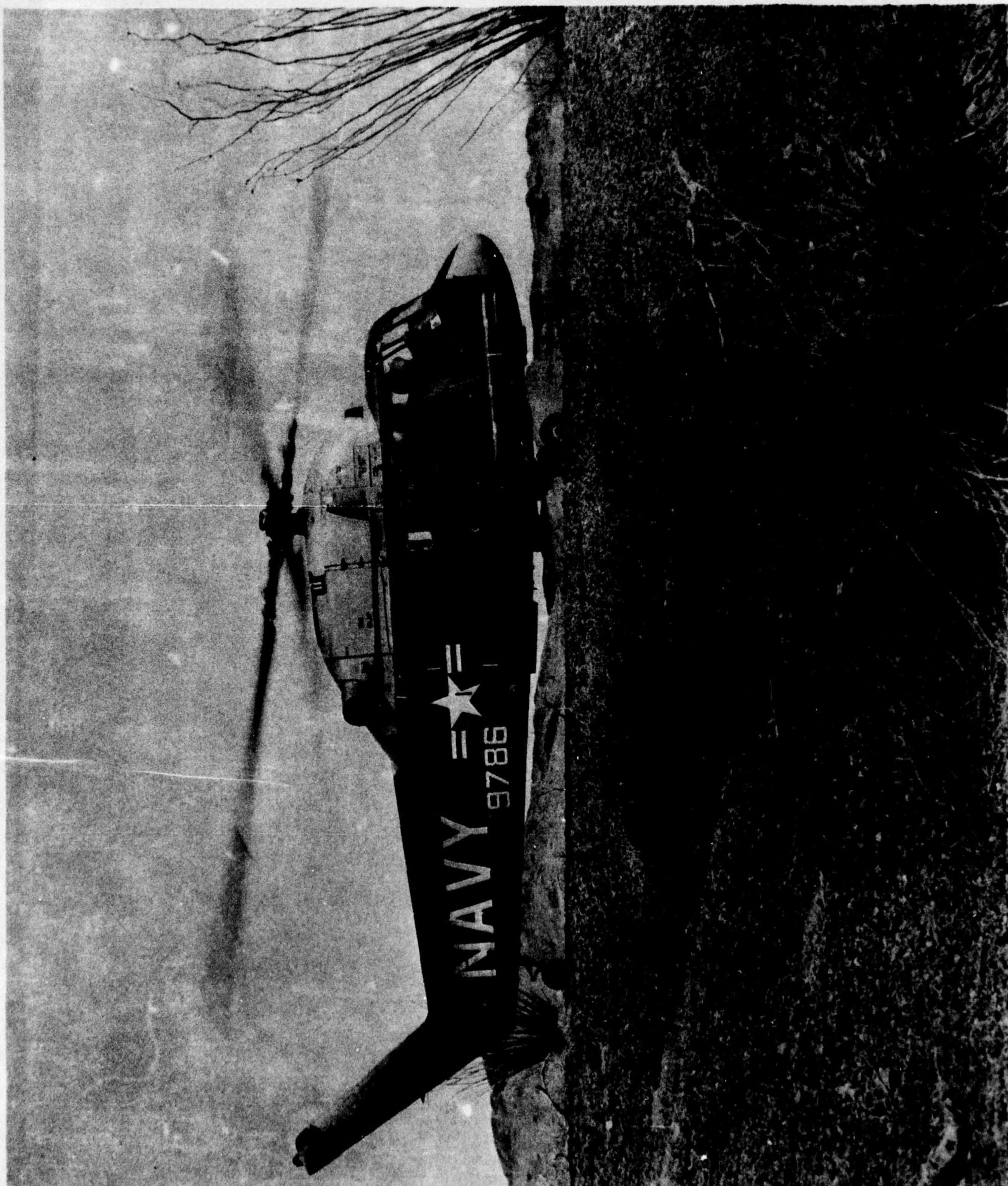

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UNITED STATES ARMY AVIATION TEST BOARD
Fort Rucker, Alabama

REPORT OF TEST

USATECOM PROJECT NO. 4-3-3171-01

MILITARY POTENTIAL TEST OF THE UH-2A HELICOPTER

Table of Contents

Page No.

PART I - GENERAL

A. References 1
B. Authority 1
C. Background 1
D. Description of Materiel 2
E. Test Objectives 4
F. Discussion 4
G. Findings 5
H. Conclusions 6
I. Recommendations 7

PART II - TEST DATA

A. Scope 9
B. Flight Envelopes 9
C. Details of Test 9

PART III - APPENDICES

A. USAAESWBD Report 55
B. US AARU Report 71
C. USABAAR Report 77
D. USAAHRU Report 81
E. Engine Problem Evaluation 85
F. Logistical Evaluation Data 89
G. Retractable Landing Gear and Cutaway of Cabin in the Litter Configuration 111
H. List of References 115

UNITED STATES ARMY AVIATION TEST BOARD
Fort Rucker, Alabama

REPORT OF TEST

USATECOM PROJECT NO. 4-3-3171-01

MILITARY POTENTIAL TEST OF THE UH-2A HELICOPTER

PART I - GENERAL

A. REFERENCES. A list of references is contained in appendix H, part III.

B. AUTHORITY.

1. Directive. Letter, AMSTE-BG, USATECOM, 17 July 1963, subject: "Directive for Military Potential Test of the UH-2A Helicopter."

2. Purpose. To determine operational performance of the UH-2A Helicopter and T58 engine in the Army environment.

C. BACKGROUND.

1. In March 1963, the Office, Chief of Research and Development (OCRD) requested US Army Materiel Command (USAMC), to evaluate the UH-2A Helicopter to determine the operational performance of the helicopter and T58 engine when operated in the Army environment. In April 1963, USAMC directed US Army Test and Evaluation Command (USATECOM) to conduct the evaluation and compare the operational performance against the standards set forth in the Qualitative Materiel Requirement (QMR) for a High-Speed Helicopter Weapons System (HSHWS). Subsequently, in July 1963, USATECOM directed the President, United States Army Aviation Test Board (USAAVNTBD), to conduct a military potential test of the UH-2A Helicopter to approximate a service-type test to include operations in the desert and at high elevations.

2. A UH-2A Helicopter, provided on a loan basis by the US Navy, was delivered to the USAAVNTBD on 15 June 1963, for operational and environmental testing.

D. DESCRIPTION OF MATERIEL.

1. The UH-2A Helicopter has a single, four-bladed main rotor, a three-bladed antitorque tail rotor, and is powered by a T58-GE-8B turboshaft engine (1250 shaft horsepower) mounted above the cabin aft of the cockpit. The main rotor is driven through the main gear box which is mounted forward of the engine. Cyclic and collective pitch control are obtained through blade flaps mounted on the main rotor blades. Aerodynamic action of the flaps changes the pitch (angle of attack) of the main rotor blades in response to the pilot's operation of the controls. The helicopter has dual flight controls and instruments for the pilot and copilot and is equipped with automatic stabilization equipment (ASE) which maintains airspeed, roll attitude, and heading established by the pilot. It has a retractable main landing gear and a full-swivel unretractable tailwheel.

2. The helicopter has three entrance doors -- one door forward on the right side which provides access to the pilot seat and rescue hatch; a forward door on the left side which provides access to the copilot seat; and a rear door on the left side which provides access to the cargo compartment. The cabin (cargo compartment) can be used to carry additional crew, passengers, litter patients, or cargo. In the standard Navy configuration, four passengers may be transported within the cabin area.

3. In its US Navy configuration, the UH-2A Helicopter is used for such missions as search and rescue, observation and reconnaissance, plane guard during aircraft carrier operations, and transportation of internal and external cargo.

4. Electronic equipment required for the Navy mission was removed, and a prototype seating arrangement for 11 troops was installed.

5. The following was taken from the US Navy Flight Manual and confirmed by physical examination of the helicopter.

a. Dimensions.

Length	Operating configuration	52 feet 3 inches

Length	Minimum with rotors, nose doors, and tail rotor pylon tip folded.	36 feet 8 inches
Width	Across main landing gear	11 feet 4 inches
	Rotor disc	44 feet
Height	Main rotor hub	12 feet 6 inches
	Tail rotor tip	14 feet 8 inches
	Main rotor minimum ground clearance.	8 feet 6 inches
	Tail rotor minimum ground clearance.	6 feet 6 inches
Cabin	Width	4 feet 6 inches
	Length	9 feet 4 inches
	Height	4 feet 7 inches

b. Weights of the Test Aircraft.

Empty helicopter weight (assumed)	5573 pounds
Basic helicopter weight	5772 pounds
Design gross weight	7378 pounds
Useful load (at design gross weight)	1606 pounds
Maximum gross weight	10, 000 pounds
Useful load (at maximum gross weight)	4, 228 pounds
Internal fuel tank capacity (JP4)	276 gal/1794 pounds
Auxiliary fuel tank capacity (JP4)	120 gal/780 pounds

E. TEST OBJECTIVES.

1. To determine under temperate conditions:

a. Physical characteristics.

b. Suitability of overall configuration.

c. Flight characteristics and performance.

d. Mission capability (in conjunction with the US Army Airborne, Electronics and Special Warfare Board).

e. Personnel and training requirements.

f. Maintenance requirements.

g. Extent to which the helicopter meets the military characteristics for a *utility/tactical transport* helicopter.

h. Aviation safety aspects (operational, maintenance, and crashworthiness).

2. To determine the effect of desert environment on the operation of the helicopter.

3. To determine the effect of high elevations on the operation of the helicopter.

4. To determine the suitability of the T58-GE-8B for Army use.

F. DISCUSSION.

1. The method, scope, and conduct of the UH-2 military potential tests approximated that of a normal service test, but involved only half the flight time (approximately 150 hours) owing to terms of the bailment agreement with the Navy. This time was broken down into 85 hours of temperate test, 50 hours of desert test, and 15 hours of test at high elevations.

2. Since the test vehicle, as modified, is more closely related to the Army's requirement for a utility/tactical transport helicopter, the test objectives for this test phase were directed toward comparison with current military characteristics for a utility/tactical transport helicopter. The armed version of the UH-2 Helicopter, which is to be tested and reported on at a later date, will be compared with the Proposed Qualitative Materiel Requirements for the High-Speed Helicopter Weapons System.

G. FINDINGS.

1. The overall physical characteristics of the UH-2A as a utility/tactical transport helicopter were unsatisfactory. Deficiencies were found in the troop-seat configuration and ease of ingress and egress from the cabin. Shortcomings were found in the instrument panel layout and lack of provisions for blackout of the cabin.

2. The overall configuration of the UH-2A was unsatisfactory. A deficiency existed in the ground-handling characteristics on soft sod and desert type surfaces, primarily as a result of inadequate landing gear flotation (250-p.s.i. tire pressure). Shortcomings were found to exist in the location of the tail rotor sight-level gauge and the restrictive lateral clearance at the external cargo hook during sling hook-up operation.

3. The UH-2A Helicopter either met or exceeded the flight characteristics and performance requirements for a utility/tactical transport helicopter. The flight characteristics and performance were found to conform to applicable data contained in BUWEPS Flight Manual.

4. Mission capability tests, conducted in conjunction with the US Army Airborne, Electronics and Special Warfare Board (appendix A), revealed that the UH-2A Helicopter offered no advantages over the present utility/tactical transport helicopter for the airdrop and air transport of personnel, supplies, and equipment.

5. Operating personnel training requirements were determined to be comparable to those required by other helicopters in the utility/tactical transport helicopter category.

6. All maintenance during conduct of this evaluation was accomplished by a team of highly skilled mechanics supplied by the manufacturer; therefore, maintenance requirements can not be considered representative of Army operations in the field. It is anticipated

that certain systems such as automatic in-flight blade tracking, automatic stabilization equipment, and retractable landing gear will increase maintenance man-hours under sustained Army field operations.

7. The extent to which the UH-2A Helicopter meets the military characteristics for a utility/tactical transport helicopter is contained in paragraph C8, part II. Of the required military characteristics, the UH-2A Helicopter met 44, did not meet 11, and 10 could not be determined.

8. Aviation safety aspects were considered in the overall design and construction of the UH-2A Helicopter. However, minor design shortcomings, affecting safety, were found to exist in areas pertaining to the cargo hook position in relation to the landing gear, lack of a rear view mirror for pilot observation of external load hook-up, ingress and egress of the cabin, crashworthiness of troop seats and fittings, and the unretractable tail wheel which constituted an obstruction to deploying personnel parachutes.

9. Operation of the UH-2A in the desert was unsatisfactory due to a progressive and unacceptable deterioration of engine performance caused by ingestion of dust and sand particles.

10. The T-58-GE-8B engine, as mounted in the UH-2A, demonstrated a short-service life as evidenced by replacement of two engines during the 150-hour test period.

11. Operations of the UH-2A Helicopter at high elevations was satisfactory. The helicopter was hovered in ground effect at a density altitude of 14,000 feet with a useful load of 2568 pounds; hovered out of ground effect at 9500 feet density altitude with a useful load of 2228 pounds; and flown in cruising flight with an indicated airspeed of 70 knots at 17,500 feet density altitude.

12. The rotor head and control system of the UH-2A Helicopter is substantially more complex than current inventory utility/tactical transport helicopters and would result in an increased cost and in maintenance man-hours.

H. CONCLUSIONS.

1. Acceptance of a relatively complex UH-2A Helicopter in the Army inventory would defeat the intent and purpose of the Army program for a low cost, easy-to-maintain helicopter, and would result in an expensive modification program and in an increased cost of maintenance up-keep in exchange for a very modest increase in performance over present utility/tactical transport helicopters.

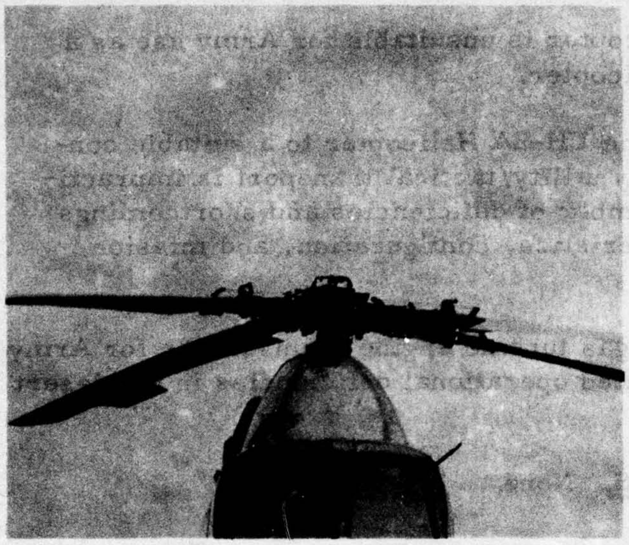
2. The UH-2A Helicopter is unsuitable for Army use as a utility/tactical transport helicopter.

3. Modification of the UH-2A Helicopter to a suitable configuration for use as an Army utility/tactical transport is impracticable because of the total number of deficiencies and shortcomings found in its physical characteristics, configuration, and mission capability.

4. The T58-GE-8B gas turbine engine is unsuitable for Army use because of its demonstrated operational deficiencies in the desert environment.

I. <u>RECOMMENDATIONS.</u> None.

A. J. RANKIN
Colonel, Armor
President



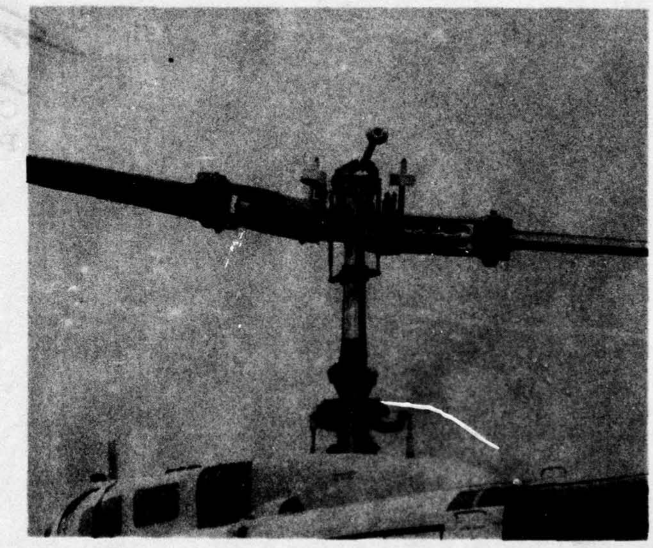


Figure 1. The UH-2A rotor head (above) and the UH-1D rotor head (below)

PART II

TEST DATA

A. SCOPE. The UH-2A Helicopter was evaluated for approximately 150 flight hours during the period 15 June to 31 August 1963, by personnel of the US Army Aviation Test Board (USAAVNTBD) in conjunction with the US Army Airborne, Electronics and Special Warfare Board (USAAESWBD) (appendix A). Also participating were the US Army Aeromedical Research Unit (appendix B), the US Army Board for Aviation Accident Research (appendix C), and the US Army Aviation Human Research Unit (appendix D).

B. FLIGHT ENVELOPES. A combination of three flight envelopes were used during the test. These were:

1. Naval Air Test Center (NATC) flight envelope.

2. Navy Bureau of Weapons (BUWEPS) flight envelope.

3. Manufacturer's flight envelope. The NATC envelope is the most restrictive while the manufacturer's envelope is the most liberal. Figure 2 shows the relationship of these envelopes.

C. DETAILS OF TEST.

1. Physical Characteristics.

a. Cockpit Configuration.

(1) Overall configuration and layout of controls and gauges were satisfactory. The engine fuel control lever on the collective pitch stick has three positions: OFF, IDLE, and FLY. The throttle is held in each of these positions by a cam and can be rotated only after applying a pressure to release the cam. The IDLE position in the UH-2A Helicopter is a "ground idle" position as opposed to a "flight idle" position found in some other turbine-powered helicopters. Engine operation at the "ground idle" setting can be accomplished continuously with the rotor blades locked. There is no "flight idle" position.

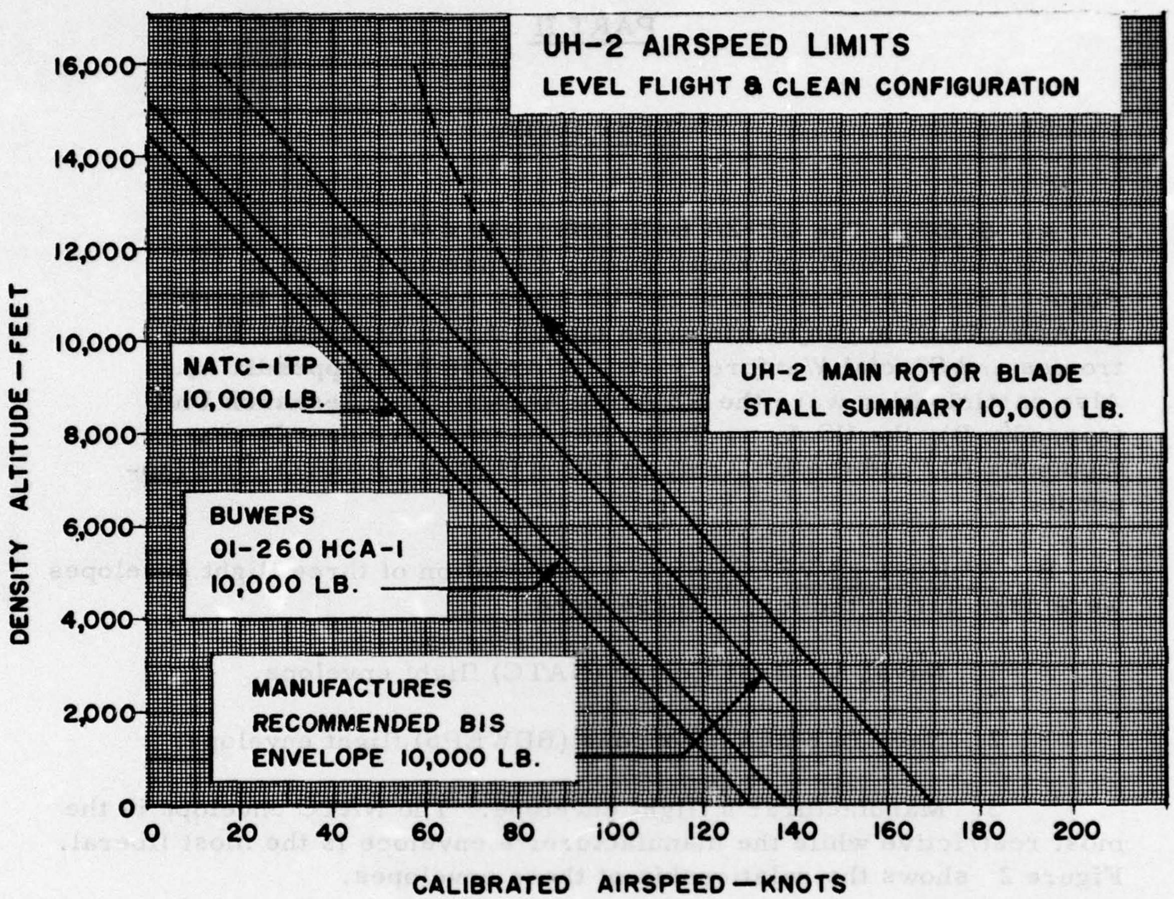

UH-2 AIRSPEED LIMITS
LEVEL FLIGHT & CLEAN CONFIGURATION
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
DENSITY ALTITUDE — FEET
NATC-ITP
10,000 LB.
UH-2 MAIN ROTOR BLADE
STALL SUMMARY 10,000 LB.
BUWEPS
01-260 HCA-1
10,000 LB.
MANUFACTURES
RECOMMENDED BIS
ENVELOPE 10,000 LB.
0
20
40
60
80
100
120
140
160
180
200
CALIBRATED AIRSPEED — KNOTS

FIGURE — 2

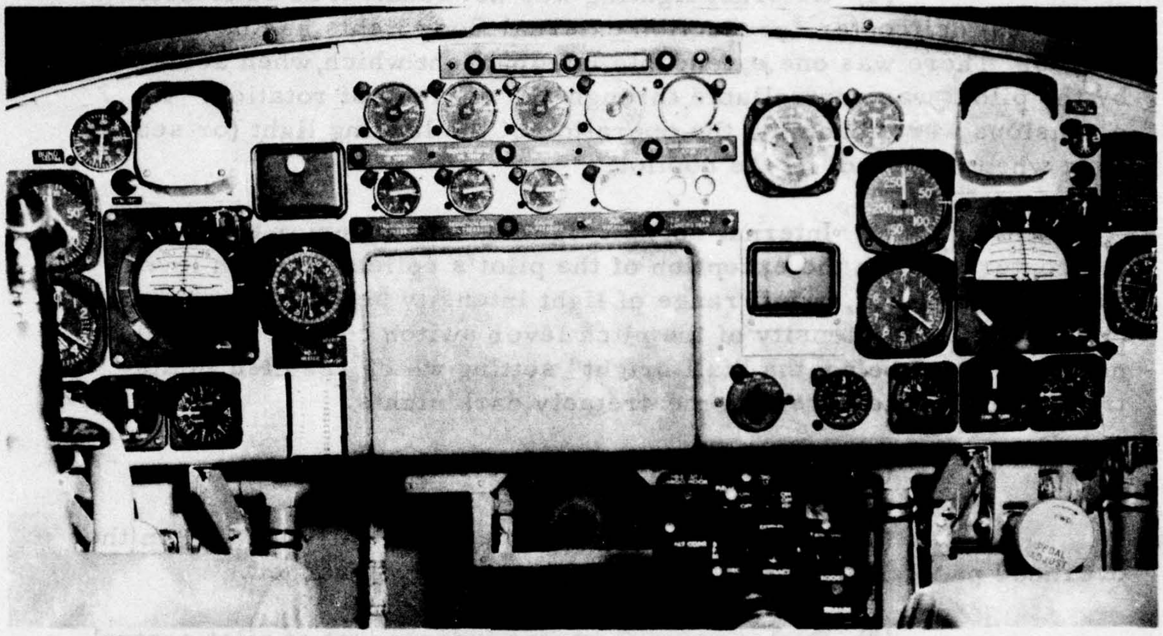


Figure 3. UH-2A Instrument Panel.

(2) The flight instruments were not arranged in accordance with the approved Army "T" panel configuration. With the exception of a rotor/engine tachometer, a complete set of alternate instruments was provided on the left side of the panel for the copilot (figure 3).

(3) The pilot's seat was adjustable up and down. The copilot's seat was not adjustable. Both pilot's and copilot's antitorque pedals were adjustable fore and aft. Personnel of various physical stature had no difficulty in reaching and moving all controls through their full travel. Conventional toe brakes which react on the main landing gear wheels were available on the pilot's antitorque pedals. No provisions for brakes were made on the copilot's side. The copilot's seat and cyclic control stick were readily removable to facilitate maintenance.

(4) External lighting was not considered satisfactory. In the test helicopter, production external flood lights had been removed. There was one extendable landing light which, when actuated by the pilot, was controllable through 360 degrees of rotation. No provisions were made for the operation of the landing light (or searchlight when installed) by the copilot.

(5) Internal cockpit lighting was superior to most helicopters. With the exception of the pilot's collective pitch lever switch control box, a full range of light intensity settings were available. The light intensity of the pitch lever switch control box could not be reduced below the "full bright" setting which resulted in distracting light interference on extremely dark nights.

(6) All switches were satisfactorily located.

(7) Emergency switches were centrally located on the overhead panel, easily identifiable, and logically arranged.

(8) Fuel management was independent of pilot control and relieved the pilot from close monitoring of the fuel state. Fuel quantity indicators, together with fuel low-level warning lights, operated satisfactorily.

(9) During each landing gear retraction, the compressor-pressure caution light came on, automatically illuminating the master caution light for approximately 10 seconds. When the auxiliary fuel tanks were installed, the compressor pressure caution light required up to 15 minutes to go off. While the flight manual cites this condition as normal, the distraction to the pilot during the critical takeoff phase is considered unsatisfactory.

(10) Provisions for standard Army helicopter electronic configuration were adequate and present no unusual avionic installation problems.

b. <u>Cabin Configuration.</u>

(1) The overall cabin configuration as presented in the test helicopter was considered unsatisfactory. This is due primarily to the left fore-and-aft troop bench and support post which partially blocks the main cabin door and the limited shoulder room at the two rear seats.

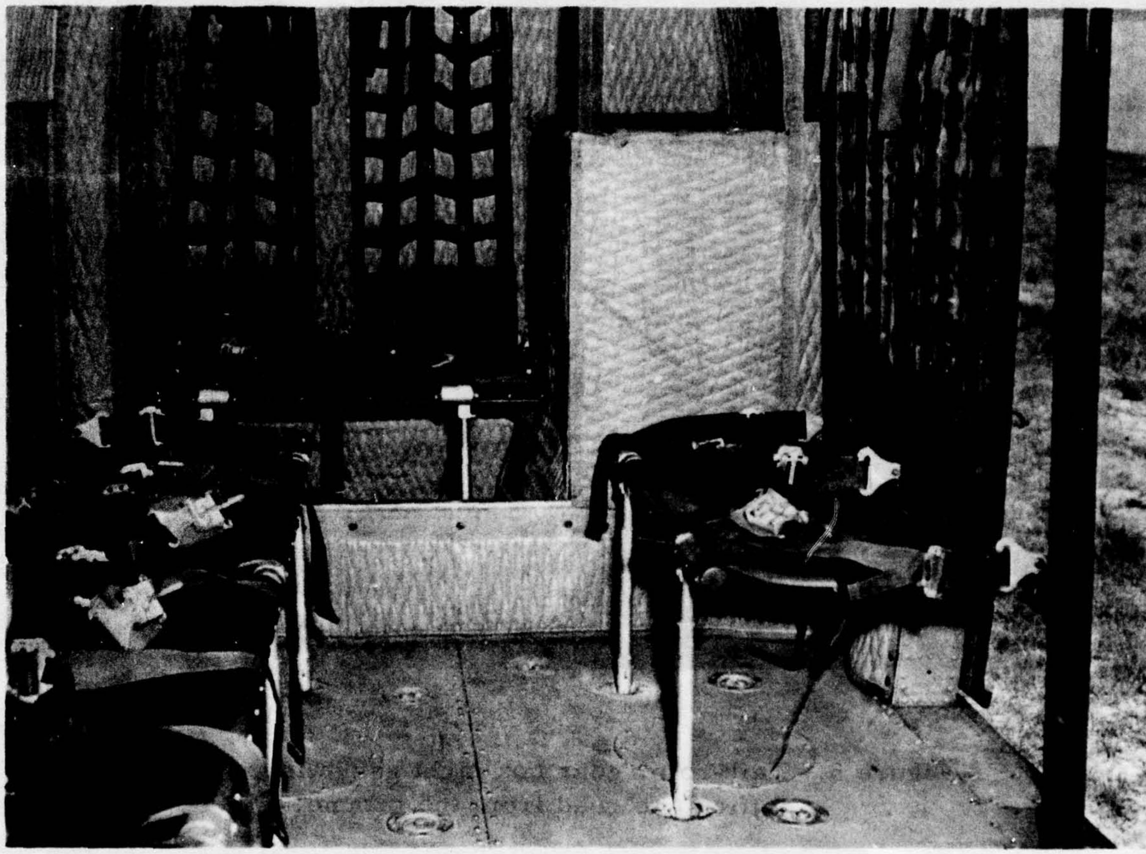


Figure 4. Part of the 11-passenger seating arrangement. Three seats across the forward bulkhead are not shown.

(2) Seats for 11 passengers were provided (figure 4).

(3) Height of cabin floor (approximately 38 inches from ground level) combined with lack of suitable external steps, created an unsatisfactory condition during ingress and egress of personnel.

(4) There were no provisions for blackout of the cabin.

Figure 5. Tail-rotor gear box sight gauge is difficult to read from the ground.

2. Suitability of Overall Configuration.

a. Servicing Requirements.

(1) Provisions for normal daily servicing of the helicopter were satisfactory. Pressure and gravity fueling points were available. All filler caps were readily accessible except for the filler cap on the right auxiliary fuel tank. This filler cap is located inboard between the tank and the helicopter fuselage, making physical and visual access difficult. Access to the various oil-type reservoirs was satisfactory. Oil reservoir sight gauges are small in diameter but are considered satisfactory. The tail-rotor gear box sight gauge, however, is recessed to a point that actual oil level is impossible to ascertain from the ground level (figure 5).

Figure 6. Access doors fold down to form work platform.

(2) Access to the engine compartment (figure 6) is satisfactory. Access doors on each side of the helicopter fold down to form work platforms. Access doors that are not used as work platforms are readily removed.

b. External Cargo Hook System. The external cargo hook had a capacity of 4000 pounds. The hook was in a fixed-forward position, closely coupled to the bottom of the fuselage. Maximum lateral clearance at the hook, with the landing gear down, was approximately 32 inches on either side of the hook. There was no visual contact between the helicopter crew and the load either at hookup or in flight. During pickup, lateral displacement of the load was limited structurally to 20 degrees. (See USAAESWBD report, appendix A.)

Figure 7. Flotation was unsatisfactory on soft sod or sand surfaces because of single, small, high-pressure main-landing-gear tires.

c. Ground Handling.

(1) No difficulty was encountered in moving the helicopter, under its own power or by tug, on hard surfaces or firm sod utilizing a standard tow-bar for towing operations. Movement on the same surfaces by manpower required five men.

(2) Difficulty was encountered in moving the helicopter on soft sod or sand surfaces with a towing vehicle; moving the helicopter by manpower was impractical. (See paragraph 4 and figure 7.) Flotation was unsatisfactory because of the single, small, high-pressure (250 p.s.i.) main-landing-gear tires. In some instances the main gear(s) would sink to a point where further attempts to move the helicopter would have resulted in material failure.

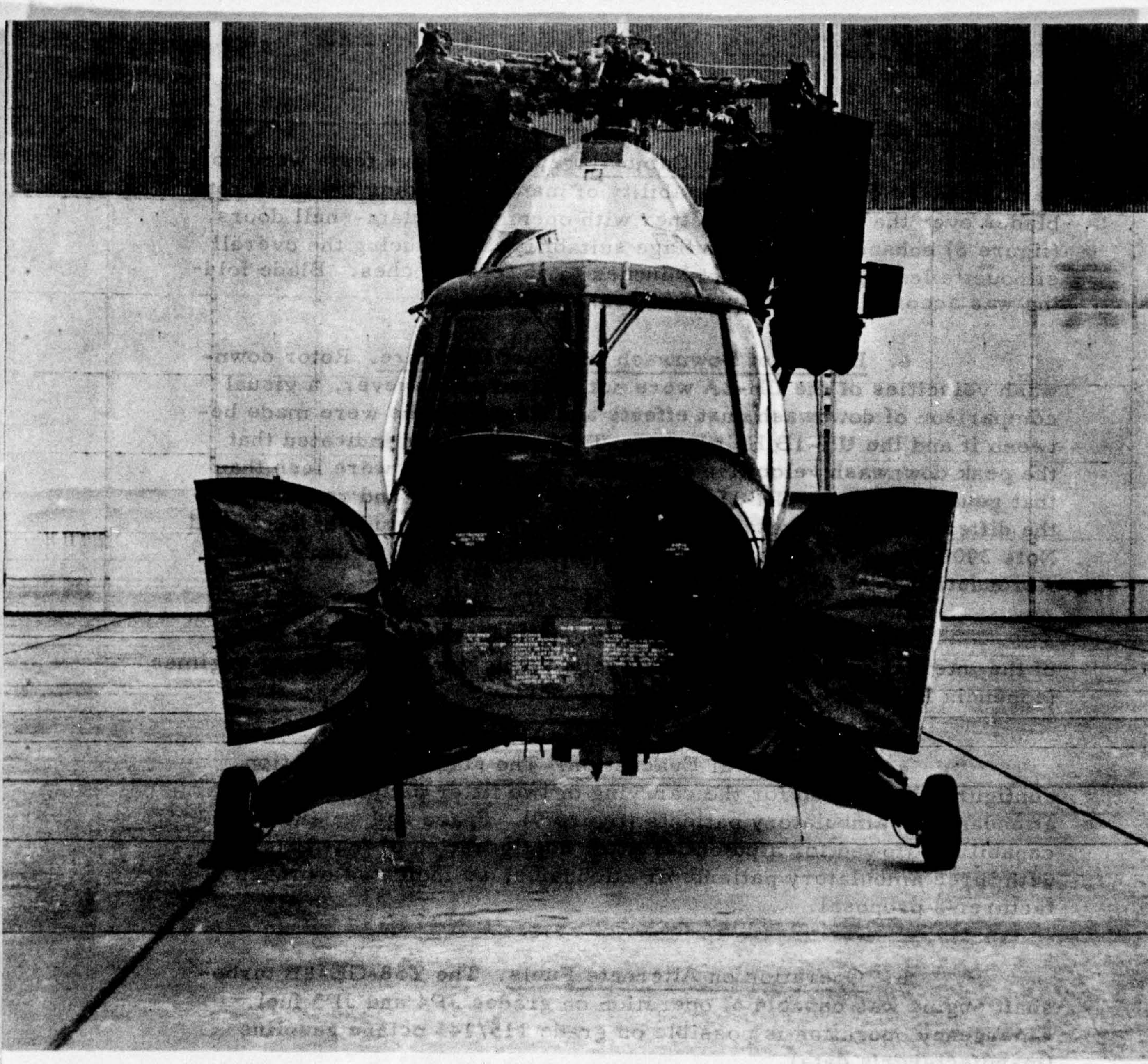


Figure 8. The UH-2A in reduced configuration.

d. Suitability for Camouflage. Camouflage tests were not performed. However, the capability of manually folding the main rotor blades over the fuselage, together with opening the clam-shell doors, (figure 8) enhances the camouflage suitability by reducing the overall silhouette length from 52 feet 3 inches to 36 feet 8 inches. Blade folding was accomplished in four minutes.

e. Effects of Downwash and Dust Signature. Rotor downwash velocities of the UH-2A were not measured; however, a visual comparison of downwash dust effects and flow patterns were made between it and the UH-1B Helicopter. This comparison indicated that the peak downwash velocities generated by the UH-2A were less than that generated by the UH-1B. The visual indications and reasons for the difference in downwash effects are confirmed by study of Technical Note 3900, page 7, published by the National Advisory Council for Aeronautics (NACA).

f. Noise Levels. Instrument measurements were made of the internal and external noise levels during various operating regimes (appendix B).

g. Aeromedical Evacuation. The standard production configuration allowed for the carrying of two litter patients and four attendants or ambulatory patients (figure 9). Space and weight capability allowed for a potential litter configuration of four litters with three ambulatory patients or attendants, as indicated by manufacturer's proposal.

h. Operation on Alternate Fuels. The T58-GE-8B turboshaft engine was capable of operation on grades JP4 and JP5 fuel. Emergency operation is possible on grade 115/145 octane gasoline (manufacturer's data).

3. Flight Characteristics and Performance.

a. Hovering Flight. Hovering flight, including forward, rearward and sideward hover, was satisfactory. The main rotor mast is tilted 4 degrees to the left, which gives the helicopter a level hover attitude, as opposed to many helicopters which hover tail and left side low.

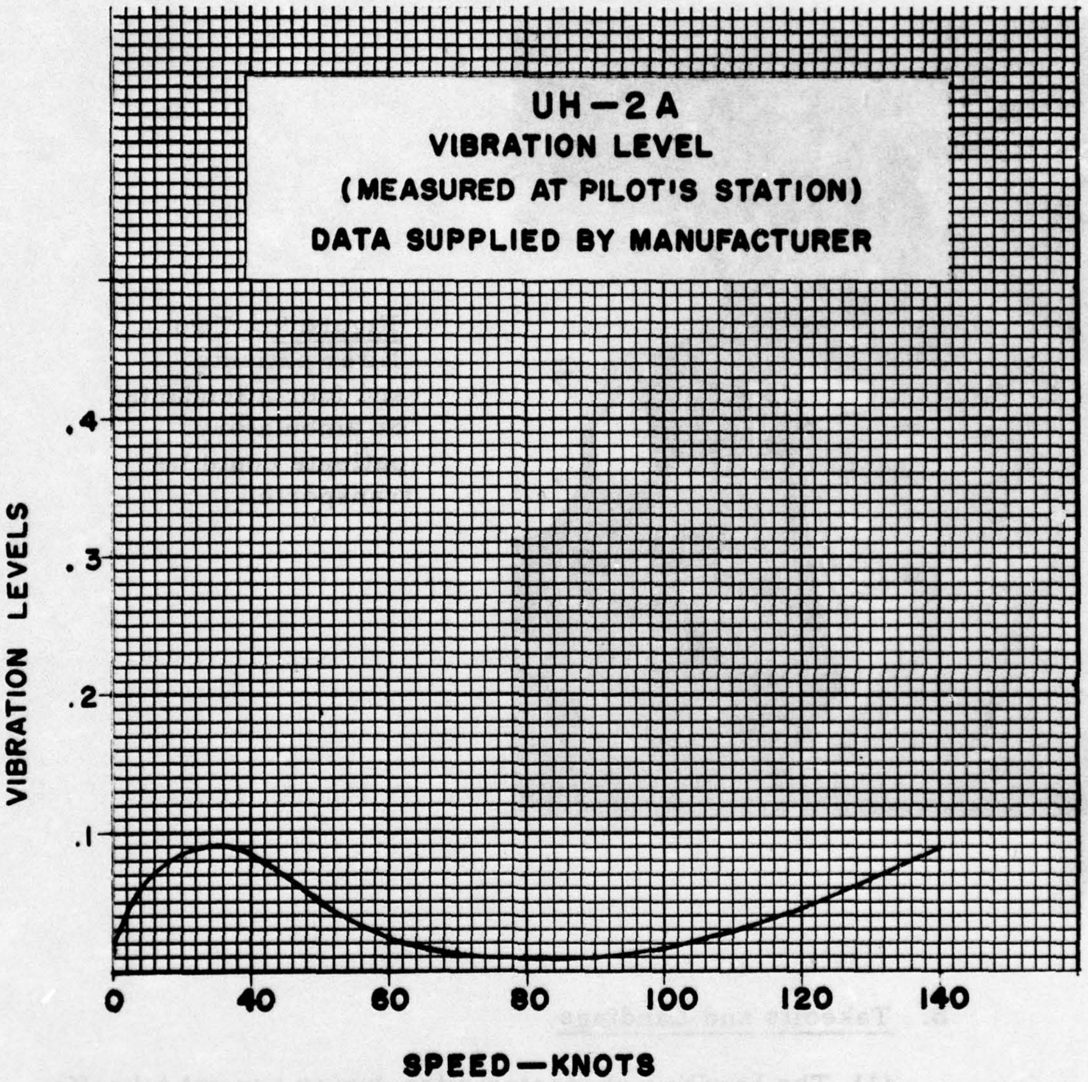
Figure 9. Two litter patients and four attendants or ambulatory patients could be transported.

b. Takeoffs and Landings.

(1) The handling characteristics during normal takeoffs and landings at various gross weights up to the maximum allowable were satisfactory. Passage through transverse flow effect was rapid and smooth. Approaches were comparable to those of other turbine powered helicopters of approximate size and weight.

(2) Maximum performance takeoffs and steep approaches were satisfactorily accomplished using standard Army techniques.

(3) Running takeoffs and landings were satisfactorily accomplished using standard Army techniques.



UH-2A
VIBRATION LEVEL
(MEASURED AT PILOT'S STATION)
DATA SUPPLIED BY MANUFACTURER
VIBRATION LEVELS
.4
.3
.2
.1
0
40
60
80
100
120
140
SPEED—KNOTS

FIGURE-10

c. Autorotations.

(1) Autorotative descents, at various gross weights up to the maximum allowable, were satisfactorily accomplished. Entry into autorotation from low-and high-speed cruising flight was comparable to other helicopters of approximate size and weight. Rate of descent at high gross weights averaged 2000 feet per minute (f.p.m.). Decreasing rotor r.p.m. to approximately 93 percent (by increasing the pitch of the main rotor blades) reduced the rate of descent to an average of 1500 f.p.m.

(2) Autorotative landings were made with little or no ground roll through use of a cyclic flare and brakes. At high density altitudes of 5000 feet or above and high gross weights of 8000 pounds or above, a short ground roll (30-50 feet) was experienced.

d. Cruising Flight.

(1) Cruising flight at various speeds and altitudes up to service ceiling (15,000 feet) was satisfactory. An outstanding characteristic of this helicopter is its low vibration levels (figure 10).

(2) At the design gross weight, the cruising airspeed at normal rated power (NRP) was 122 knots calibrated airspeed (CAS). At the maximum overload gross weight, the cruise airspeed was 108 knots CAS.

e. Flight at Maximum Power. The helicopter was flown at speeds up to 147 knots CAS. There were more inherent vibrations at these higher speeds; however, these vibrations were not objectionable and the overall flight handling characteristics were considered above average. With the helicopter at weights up to design gross, the maximum speed in straight and level flight was 138 knots CAS with maximum military power.

f. Settling with Power. Flight characteristics of the helicopter during settling with power (actually, a condition of settling with insufficient power) were satisfactory. Recovery from this condition was normal and comparable to other single-rotor helicopters.

g. Slope Landings. Landings on slopes up to 16 degrees were satisfactorily completed. Landings with the helicopter pointed

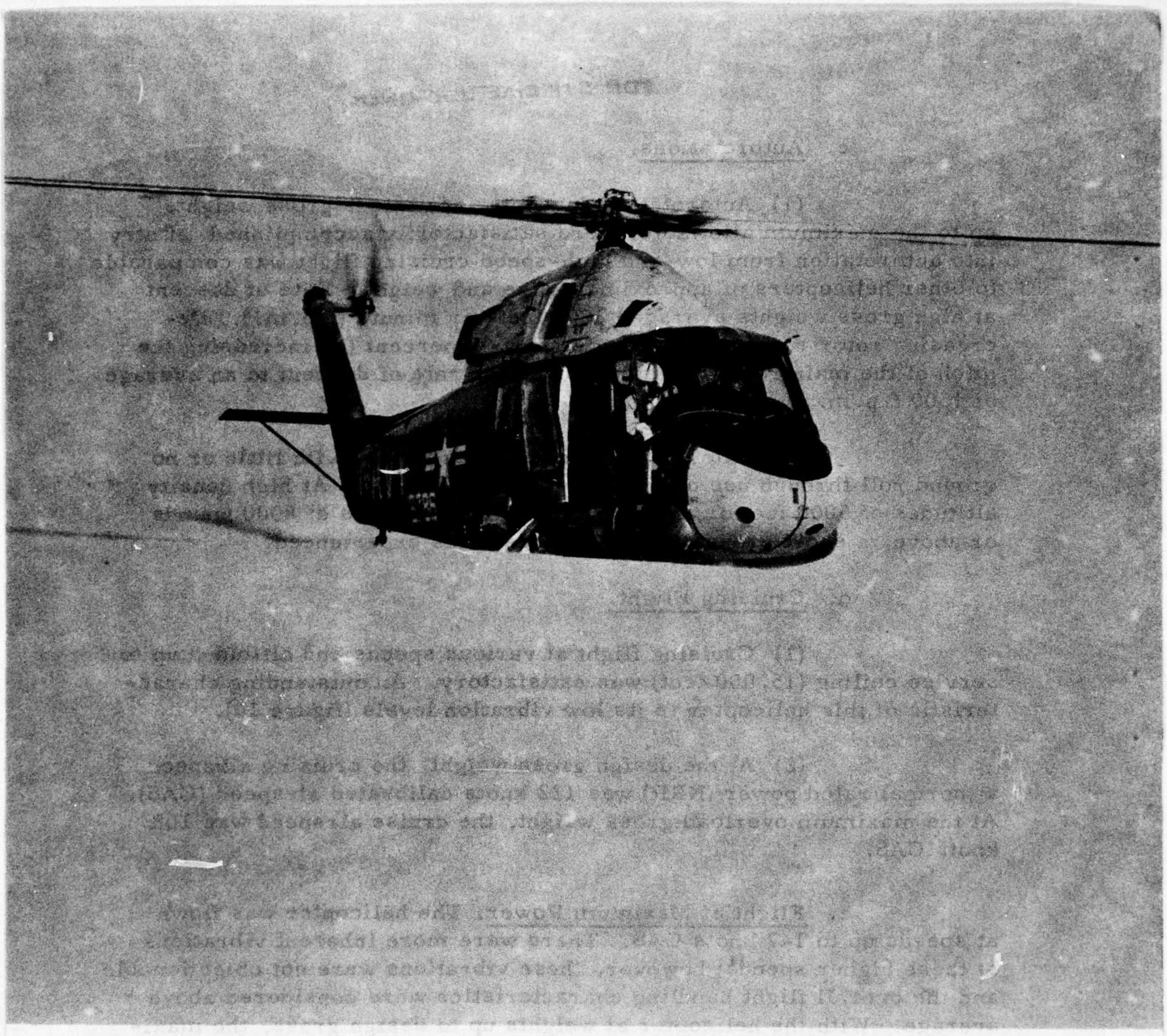


Figure 11. The UH-2A during operation in sand dunes.

up-slope, down-slope, and cross-slope were accomplished. Landings on 16-degree slopes with the right side up-slope were critical due to the designed left tilt of the rotor mast.

h. Radius of Action. Reduction of flight test performance data to NASA Standard Day (standard-day, sea-level conditions) verified that the UH-2A Helicopter met radius-of-action requirements for a utility/tactical transport helicopter. Actual radius limits were:

(1) With a pilot, internal fuel load (JP4) of 1760 pounds, and 1540 pounds of payload (both ways), the UH-2A Helicopter was capable of a radius-of-action mission of 124 nautical miles at a true airspeed of 100 knots, with a 30-minute fuel reserve. This exceeds the requirement for a 100-nautical-mile radius under these conditions.

(2) With a pilot, internal fuel load (JP4) of 1760 pounds, and 2200 pounds of payload, the helicopter was capable of flying out more than 125 nautical miles, dropping off the original payload, picking up 800 pounds of payload and returning with a 30-minute fuel reserve at 100 knots true airspeed. This exceeds the requirement of 100 nautical miles under these conditions.

i. Automatic In-Flight Blade Tracking. The automatic in-flight blade tracking system was utilized throughout the evaluation period. This system, while not essential to flight operations, provides a constant input to the blade flaps to correct for lateral vibrations at a hover and vertical vibrations in forward flight. The system does not eliminate the requirement for "flag" tracking when changing blades but does correct minor out-of-track conditions. These minor out-of-track conditions would be a result of bearing wear, blade wear, and/or damage. Short periods of flight with the tracking system intentionally inoperative were made with no noticeable adverse flight characteristics. No maintenance was required on this system during the test period.

4. Desert Test Phase. The desert test phase was conducted in the vicinity of Yuma Test Station Arizona, during the period 13 July to 2 August 1963. Surface ambient temperatures during this test period ranged from 86° to 123°F. Only those test results that apply specifically to desert type operations will be reported in this section. Flight characteristics and performance under desert conditions were satisfactory and compared favorably with those under temperature conditions. The following were determined:.

a. Performance.

(1.) Running takeoffs and landings were performed with satisfactory results on various desert surfaces except volcanic rock surfaces. During operations from volcanic rock surfaces, small, sharp rocks had a tendency to cut or gouge the main landing gear tires but did not noticeably impair their serviceability.

(2) Maximum performance takeoffs utilizing maximum available military power were performed at high ambient temperatures with the following recorded results. Performance did not differ significantly from that obtained under temperate conditions.

Ambient Temp. (^{O}F.)	Gross Weight (lb.)	Rate of Climb (f.p.m.)	Surface Density Altitude (ft.)
104	7000	1800	4000
104	7500	1600	4000
104	8000	1450	4000
104	8500	1270	4000
101	9000	1000	3800
91	9600	640	2800

(3) Hovering in ground effect was performed at a gross weight of 9650 pounds at a density altitude of 2800 feet, with an outside air temperature (OAT) of 104^{O}F.

(4) At a gross weight of 8700 pounds, the UH-2A was hovered out of ground effect at a density altitude of approximately 5700 feet with an OAT of 99^{O}F.

(5) A climb to service ceiling (15,000 feet density altitude) was attempted with the helicopter at 9650 pounds gross weight. Service ceiling was not reached due to the expiration of the 30-minute limit on operation of the engine at maximum available military power. At this limit the indicated rate of climb was 150 feet per minute and a density altitude of 12,600 feet had been attained.

b. Operating Temperatures.

(1) The helicopter was hovered for approximately 15 minutes at a gross weight of 8000 pounds with an outside air temperature of 102°F. All operating temperatures and pressures remained well within the limits and increased only slightly over temperatures recorded during normal flight operations. Listed below, for comparative purposes, are temperatures and pressures recorded during normal flight operations and the 15-minute hover.

	Operating Limits	Normal Flight Reading	Extended Hover Reading
Transmission oil temp. (°C.)	50-120	76	79
Main-rotor gear box oil temp. (°C.)	50-120	93.5	99.0
Engine oil temp. (°C.)	70-120	92	96
Transmission oil pressure (p.s.i.)	20-85	46	45
Main-rotor gear box oil pressure (p.s.i.)	8-100	40	40
Engine oil pressure (p.s.i.)	10-60	32	36

c. Blade Erosion.

(1) Standard Navy production UH-2A's are equipped with main rotor blades which have a 0.011-inch-thick metal erosion strip on the leading edge. For the purpose of this evaluation, three of the main rotor blades were equipped with a 0.015-inch-thick metal erosion strip and one with the standard production 0.011-inch-thick erosion strip.

(2) Rotor blades which had the 0.015-inch-thick erosion strip showed only slight erosion. Rocks and stones picked up by the rotor downwash caused small dents, primarily in the rotor blade tip-caps (figure 12).

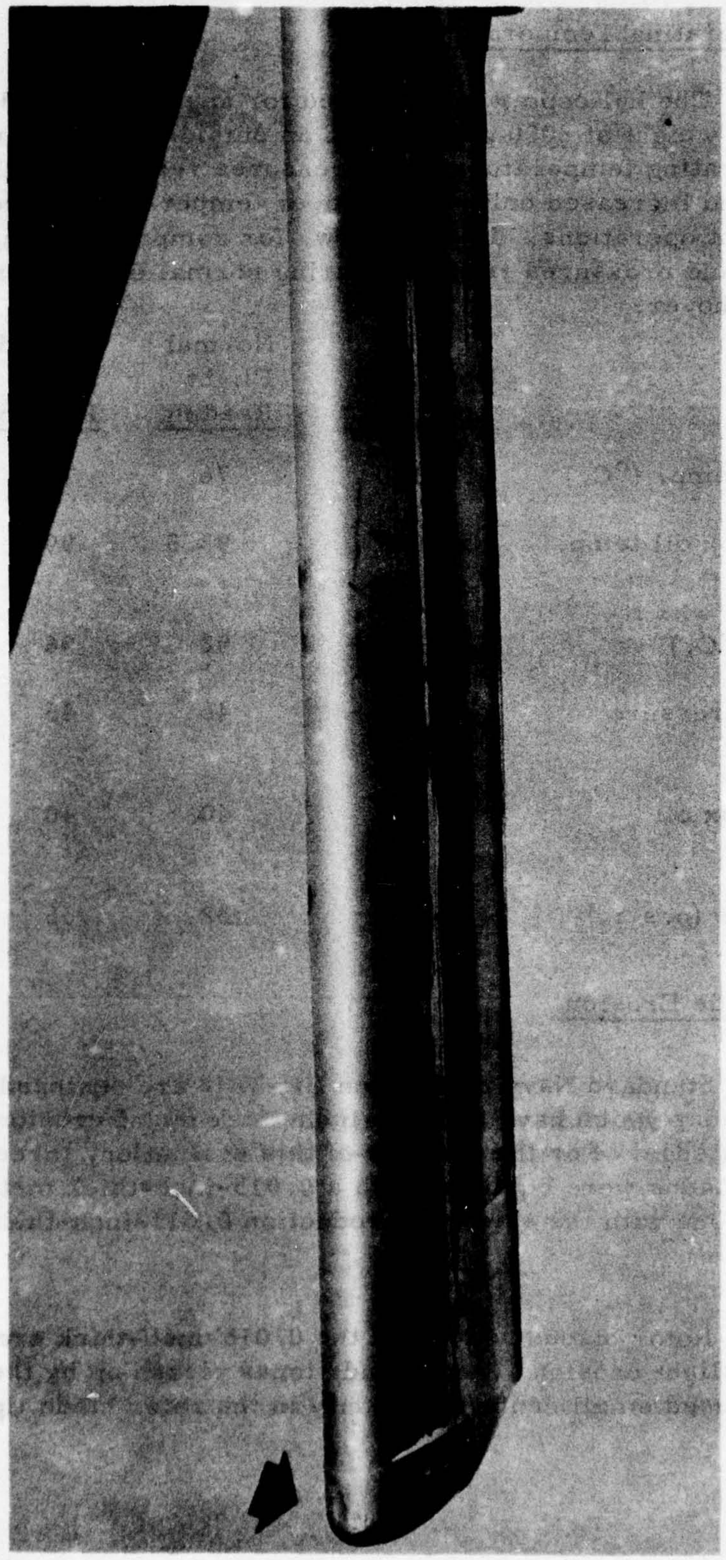


Figure 12. Arrow points to dents in the rotor blade tip cap. The 0.015-inch-metal erosion strip along the leading edge of the blade shows little erosive effect.

Figure 13. The rotor blade with the 0.011-inch-thick metal erosion strip in the leading edge showed appreciably more erosive effect.

Figure 14. Tail-rotor blades showed mild erosion.

(3) The rotor blade with the 0.011-inch-thick erosion strip showed appreciably more erosive effect from rocks and stones (figure 13).

(4) At the completion of the desert test, a satisfactory field expedient fix was made by hand dressing the leading edges, polishing the blades and filling small dents with a commercial filler supplied by the helicopter manufacturer. Care was taken in applying the filler to avoid an out-of-balance condition. As a result of this fix, blade change was not necessary.

(5) Tail rotor blades showed mild erosion (figure 14), but required no special maintenance techniques.

(6) A thin crack was noted in the under side of one of the main rotor blades between pockets. It was determined that this defect in no way affected the structural integrity of the blade. Since the blades are Fiberglas construction, a simple Fiberglas patch was made with excellent results.

d. Troop and Crew Compartment Temperatures.

(1) With seven troops plus pilot and copilot, the helicopter was hovered and flown through a series of takeoffs and landings from various desert surfaces. With an outside air temperature of 104°F. and the cockpit doors open, the ambient temperatures in the troop and crew compartment averaged 3°F. higher than free air temperatures; with all doors closed, the differential was 4°F.; and with all doors open the differential was 2°F.

(2) Similar flights with two litter patients and one qualified medical attendant aboard were made with a free air temperature of 100°F. The litter occupants were reasonably comfortable during hover and cruising operations. Air circulation around the litters was satisfactory (appendix B).

e. T58 Engine.

(1) Sand and dust ingestion resulted in three engine deceleration stalls. The first stall occurred after 8.25 hours of desert test time (73.75 hours total engine time). The engine was removed and shipped to the manufacturer for tear-down analysis. The second engine, after 27.6 hours desert test time also experienced a deceleration stall. Based on test cell analysis on the first engine, a fix was accomplished which consisted of a readjustment of the variable stator vanes. This adjustment resulted in a fully operational engine. Prior to this deceleration stall and before stator vane adjustment, there had been a noted loss of available power which was estimated to be 200 shaft horsepower.

(2) A second deceleration stall of the second engine occurred approximately 14.4 hours after stator vane adjustment. At this time, approximately 42 hours of desert test time had been accumulated on this engine. Based on recommendations from the engine manufacturer, the first and second stage blades were hand stoned to remove burrs. A test flight revealed that approximately 100 shaft horsepower was regained. After completion of test flight, the engine was subsequently removed and returned to the contractor for further analysis of engine deterioration and effects of field fixes. Engine-problem evaluation is contained in appendix E.

5. High-Elevation Phase. The high-elevation phase of testing was conducted in the vicinity of Fort Carson, Colorado, during the period 3 - 9 August 1963. Flight characteristics and performance at high elevations were satisfactory and compared favorably with those at low elevations. The following was accomplished:

a. Hovering in ground effect at design gross weight (8637 pounds) and a density altitude of 9000 feet.

b. Hovering out of ground effect at a gross weight of 8000 pounds and a density altitude of 9500 feet.

c. Hovering in ground effect at a gross weight of 7340 pounds and a density altitude of 14, 000 feet (Pikes Peak). It was estimated that it would be possible to hover at this altitude with a maximum gross weight of 7500 pounds.

d. The helicopter was flown at a pressure altitude of 15, 000 feet (17, 500 density altitude) and at an indicated airspeed of 70 knots. There was a definite lack of control responsiveness; however, this condition is symptomatic of reduced air density, and is inherent in all helicopters at high elevations.

6. Personnel.

a. It was determined that the transition of rotary-wing aviators to the UH-2A Helicopter was comparable to other helicopters of similar size and weight. Aviators previously qualified in turbine-powered rotary-wing aircraft required considerably less time to transition than aviators who are not turbine qualified.

b. The test aircraft was not maintained by Army mechanics. It is assumed that on-the-job training or maintenance schooling similar to that given to mechanics on the utility/tactical transport helicopter presently classified Standard A, would be adequate to qualify Army mechanics.

c. The US Navy Flight Manual (NAVWEPS 01-260HCA-1) is not considered adequate for Army use. There is a distinct lack of

performance charts and data required for world-wide Army operations. Data contained in the manual was found within acceptable limits of accuracy for computed flight data.

d. The US Navy Maintenance Manuals (NAVWEPS) were evaluated for general content. Although these manuals are in a Navy format and echelons of maintenance do not conform to Army maintenance schedules, it was determined that the contents are adequate and, with editing, could be acceptable for Army use.

7. Logistical Evaluation. Test time was not of sufficient duration to develop trends and wear patterns. The following logistical evaluation data are included for information. Parts usage, man-hours, and POL data were taken from the daily flight and maintenance records. Other aspects of maintenance evaluation were obtained through contact with maintenance personnel.

a. Safety Considerations.

(1) The high pressure main landing gear tires (250 p. s. i.) are not common to Army aircraft, and their introduction into the supply system would require the publication of appropriate Technical Manuals (TM's) to orient the user with the inherent safety hazard of this type tire.

(2) The main landing gear tire rubber casing is impregnated with wire strands. A worn tire exposed some of these wires, and brushing against them with bare hands or skin caused small cuts and abrasions. Although this was not considered an unsatisfactory condition, safety education is required.

b. Areas Conducive to Ease of Maintenance.

(1) Manual blade-folding capability permitted reduction in space required for maintenance and storage.

(2) Numerous pull-out steps were provided to facilitate scaling to upper fuselage.

(3) A Fiberglas safety cover was provided which covered the entire top of the cockpit canopy to preclude accidental damage to Plexiglas while performing maintenance.

(4) The copilot's seat was installed with a screw-on-lock assembly which facilitated quick and easy removal and installation.

(5) Convenient access to avionics and associated electrical equipment was through the nose clam-shell doors.

c. Areas Not Conducive to Ease of Maintenance.

(1) Readability of the tail rotor gear box oil sight gauge was unsatisfactory.

(2) Steps and hand-holds provided on the aft pylon were inadequate.

d. Ground Support Equipment.

(1) Ground support equipment utilized was of a standard type found in the Army maintenance system. Subject equipment was found to be compatible to the UH-2A Helicopter, with two minor exceptions:

(a) The standard auxiliary power unit (APU) utilized for ground start power, was found to be of minimum amperage to give a start without the danger of a "hot-start." This problem was corrected by connecting two APU's in parallel. This problem also exists in starting turbine engines in other Army aircraft.

(b) The standard aircraft tow-bar, when attached to main gear, is suitable for towing the UH-2A Helicopter. When towing by the tail-wheel (the least desirable method), the tow-bar does not have a usable safety-pin hole on the cross bar. Drilling a hole in the tow-bar does not affect its serviceability.

e. Publications. Navy maintenance manuals (NAVWEPS) were utilized throughout the test period in order to monitor the maintenance procedures used by the factory contract maintenance personnel.

(1) Weight and balance information, as contained in AN 01-1B-40, was adequate and could be utilized, without modification, by Army personnel. No weight and balance computer was provided.

(2) The Navy system of listing special tools, trouble-shooting, and consumable materials by system is considered excellent.

f. Special Tools.

(1) All special tools were furnished by the maintenance contractor and were found to be satisfactory.

(2) The hoist assembly (figure 14) constituted a very significant advance as an ease-of-maintenance feature. It proved to be of excellent design and was used to great advantage in the field. It has the capability of lifting all major components on or off the helicopter except the tail rotor group. A list of special tools is included in appendix F.

g. Statistical Data.

(1) All maintenance during the conduct of this evaluation was accomplished by a team of highly skilled mechanics supplied by the manufacturer; therefore, maintenance requirements can not be considered representative of Army operations in the field.

(2) The UH-2A was flown a total of 147 hours during this evaluation. The following data were recorded:

(a) POL Consumptions.

1. 10,418 gallons of JP4. Average consumption rate was 137 gallons per hour.

2. One quart of engine oil, MIL 7808. This was in addition to that required to fully service two engines during engine change.

3. One quart of hydraulic fluid, MIL 5606. Used to replace spillage while disconnecting lines during maintenance.

4. Five pounds of grease, MIL 25537. Used to lubricate main rotor.

5. Six pounds of grease, MIL 2164A. Used to lubricate tail rotor. Not common to Army supply system.

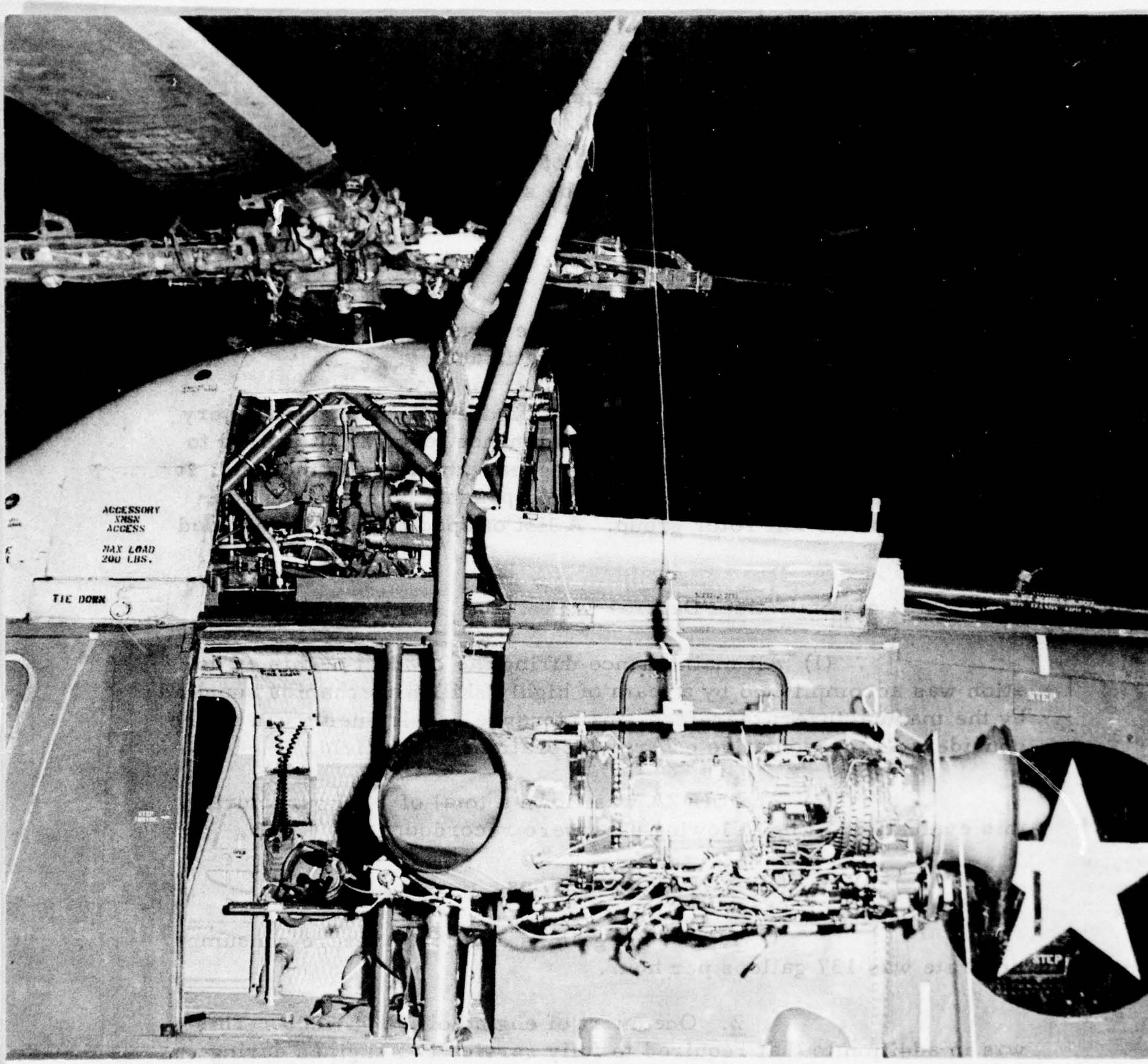


Figure 15. The hoist assembly was used to great advantage in the field.

(b) Flight-to-Maintenance Ratio. A total of 119:45 man-hours of maintenance was expended for a total flight-to-maintenance ratio of 1.2:1. Ratio by echelons is as follows:

1. A total of 38:05 man-hours of second-echelon maintenance for a flight-to-maintenance ratio of 3.9:1.

2. A total of 64:10 man-hours of third-echelon maintenance for a flight-to-maintenance ratio of 2.3:1.

3. A total of 14:30 man-hours of fourth-echelon maintenance for a flight-to-maintenance ratio of 8.4:1.

(c) Scheduled and Unscheduled Maintenance.

1. A total of 87:45 man-hours of unscheduled maintenance was expended for flight-to-unscheduled-maintenance ratio of 1.7:1.

2. A total of 32 man-hours of scheduled maintenance was expended for a flight-to-scheduled-maintenance ratio of 4.6:1.

3. Of the 87:45 man-hours of unscheduled maintenance expended, 39:45 man-hours were expended in accomplishing two engine changes, and 15:00 man-hours in tear-down and reassembly of one engine compressor.

h. Maintenance Trends. The amount of time involved in this evaluation was insufficient for the development of any definite maintenance trends; however, the following two systems accounted for an abnormal number of discrepancy entries:

(1) Tail wheel - 7 entries of which the majority pertained to the lock assembly.

(2) Tail rotor - 10 entries of which 7 pertained to the flapping bearing assembly. A complete listing of all maintenance discrepancies is contained in appendix F.

i. Overhaul Times. Times between overhaul (TBO) on all components are listed in appendix F.

8. Military Characteristics. A point-by-point comparison of the UH-2A Helicopter against the revised military characteristics (MC's) for a utility/tactical transport helicopter follows (MC's are grouped according to "required" and "desired"):

a. Required.

Required MC	UH-2A Meets MC's	Remarks
(1) Payload (useful load less 200-pound pilot, oil and fuel per paragraph 2 and 3 below)....... 1540 pounds.	Yes	
(2) Cruise speed... 100 knots.	Yes	Normal cruise approximately 120 knots.
(3) Operating radius at cruise speed at sea level (full payload both ways with 30 minute fuel reserve).. 100 nautical miles.	Yes	Data computed indicates actual radius of 124 nautical miles at 100 knots cruise speed and at a takeoff gross weight of 9326 pounds.
(4) In addition to the above performance, the helicopter shall have an alternate capability of a payload (useful load less 200-pound pilot and copilot, oil, and fuel for 100-nautical-mile-radius mission at cruise speed plus 30 minute reserve) of at least 10 combat-equipped troops (220 pounds each) being flown one way with an 800 pound return payload. (All capabilities are under NASA standard conditions at sea level.)	Yes	Data computed indicates actual radius of 128 nautical miles at 100 knots cruise speed and at a takeoff gross weight of 9986 pounds.
(5) The aircraft structure and dynamic components must be capable of utilizing the maximum continuous capacity of the power system for external and internal lift under NASA standard conditions at sea level.	Yes	Structure and dynamic components are rated to 1400 shaft horsepower (s.hp.) T58 develops 1250 s.hp.

Required MC	UH-2A Meets MC's	Remarks
(6) Under all conditions safe autorotation shall be possible in the event of power failure. If servo or control boost is used, such mechanism shall be operable during autorotation.	Yes	
(7) Helicopter will operate on standard Army fuel grade JP4 (MIL-F-5624A) and on grade 115/145 (MIL-F-5572) only as an emergency alternate.	Yes	Alternate fuel usage data are from the manufacturer.
Materiel requirements.		
Structure and design:		
General.		
(8) Minimum size consistent with requirement to carry ten combat-equipped troops, pilot, and copilot.	Yes	
(9) Center of gravity limits to allow reasonably indiscriminate loading of troops and cargo.	Yes	
(10) Design to permit operation from slopes up to 10^{o} (15^{o} desired).	Yes	Landings on 16-degree slopes accomplished.
(11) Ground clearance of at least 15 inches at a gross weight of 6600 pounds.	Yes	Empty weight - 5772 lb. Gross weight - 10,000 lb.
(12) Provisions for hoisting, jacking, mooring, and for ground-handling on soft ground.	Yes	Soft ground operation limited.

Required MC	UH-2A Meets MC's	Remarks
(13) An external load capability of 4000 pounds.	Yes	By exceeding the present gross weight limitation.
(14) Nonsusceptibility to mechanical instability, and to fly-wheel type resonance either on the ground or in flight.	Yes	Within normal operating procedures.
(15) System for defrosting transparent areas to provide adequate visibility for pilot and copilot in forward and vertical flight.	Yes	Electrically heated windshields; hot-air-heated side windows.
(16) Design of fuel system compatible with standard Army fueling and defueling equipment.	Yes	Gravity and pressure systems.
Crew station.		
(17) Army "T" instrument panel configuration for pilot with critical backup copilot instruments to permit instrument flight.	No	Not standard on Navy production. Instruments could be arranged to give standard Army "T" panel layout.
(18) Side by side seats, adjustable fore, aft, and vertically.	No	Pilot seat will adjust vertically only; copilot seat is not adjustable; both sets of pedals are adjustable.
(19) Dual primary flight controls. The copilot's seat and cyclic stick shall be readily removable.	Yes	
(20) Adjustable directional control pedals.	Yes	
(21) Maximum practical all-around visibility for pilot and copilot.	Yes	

Required MC	UH-2A Meets MC's	Remarks
(22) Doors and emergency exits from the cockpit of sufficient size and located to permit exit of pilot and copilot wearing winter clothing.	Yes	Estimated.
(23) External load release, and an emergency release independent of the primary system, accessible to the pilot and copilot. Automatic release on touchdown is not desired.	Yes	Auto-release available if desired.
Troop/Cargo Compartment.		
(24) Troop seats, preferably of the variable width type, designed to reduce crash injury, for ten combat equipped troops.	Yes	
(25) Sliding cargo doors on each side, operable in flight, of sufficient height and width to expedite unloading and loading of troops and cargo. Suitable means of ground emergency exit shall be provided.	Yes	Right door of minimal size.
(26) An internal litter transport capability for a minimum of four litters and a medical attendant so arranged as to provide ease of loading and unloading by two persons.	No	Two litter patients on Navy production helicopter with seven ambulatory patients. Three persons are required to handle litters.
(27) Maximum possible visibility from the troop compartment.	Yes	

Required MC	UH-2A Meets MC's	Remarks
Integral equipment.		
General		
(28) A self-contained starter system that does not normally require an external power source.	Yes	
(29) Removable external mirror(s) for the pilot to facilitate handling of external load.	No	Not on production aircraft. Manufacturer has drawings.
Electrical.		
(30) Standard Army external power receptacle.	Yes	
(31) Lighting.		
(a) Adequate lights for night operation.	Yes	Test aircraft was not configured as production helicopter and was not considered adequate. Production lighting is considered adequate.
(b) Anticollision lights. (Non-tactical equipment - removable components chargeable to payload.)	Yes	
Environmental protection.		
(32) Design shall minimize fire danger by location of the heater and engine exhaust with reference to fuel vents and vegetation, and for protection of crew members and passengers from carbon monoxide.	Yes	

Required MC	UH-2A Meets MC's	Remarks
(33) Crashworthiness features incorporated in seats and other critical design areas.	Yes	Some passenger seats were not of optimum design installation.
(34) (Armament) Provisions for installation of appropriate "Helicopter Armament Kits". Designation of these kits is established by separate documents.	Undetermined	
Associated equipment.		
Avionics		
(35) UHF radio.	Yes	AN/ ARC-52, powered by alternating current.
(36) Complete provisioning for VHF radio.	No	Not standard to Navy operations.
(37) FM radio with auxiliary receiver.	No	Not standard to Navy operations.
(38) Intercommunications system. (3 stations)	Yes	AN/ AIC-14.
(39) Automatic direction finding equipment.	Yes	AN/ ARN-59.
(40) VHF Omni Range Receiver.	Yes	AN/ ARN-21 (TACAN). VHF not standard to Navy operation.
(41) FM Homer.	No	Had AN/ ARN-25 (UHF DF). FM not standard to Navy operations.

Required MC	UH-2A Meets MC's	Remarks
(42) Space, weight, and power provisions for absolute altimeter.	Yes	AN/APN-117 radar altimeter.
(43) Complete provisioning for IFF equipment with SIF.	Yes	AN/APX-6B and AN/APA-89.
(44) Gyro magnetic compass.	Yes	MA-1.
(45) Radio Marker Beacon Receiver.	No	Not standard to Navy operations.
(46) Provisions for emergency VHF.	No	Not standard to Navy operations.
(47) Space, weight, and power provisions for HF radio.	Yes	AN/ARC-39.
(48) Space, weight, and power provisions for IFF Transponder (Mark XII).	Undetermined	
(49) (Radiacmeter) Space shall be provided for eventual installation of a radiacmeter.	Undetermined	
(50) (Armament) (Required for missile aircraft) Yaw component AN/ASW-12 stabilization system. See item 34.	Yes	Has complete three axis automatic stabilization system, not AN/ASW-12.
Durability and reliability.		
(51) Maximum consideration shall be given to forward area supportability. This helicopter must be easy to maintain and operate with a minimum of support personnel. Field replacement of commonly damaged or worn out components without special tools is required. Time between periodic inspections shall be the maximum practicable.	Undetermined	This requirement could not be determined owing to the limited evaluation time and utilization of manufacturer maintenance personnel.

Required MC	UH-2A Meets MC's	Remarks
(52) (Transportability) Provisions for disassembly in the field for unrestricted transportability to include Phase II of an airborne operation, and sea transportability with suitable lifting and tie-down devices provided.	Undetermined	
Maintenance.		
(53) Ease of unit replacement of major components under field conditions. Quick disconnects shall be utilized wherever possible. The go-no-go design principle shall be employed throughout.	Yes	
(54) Ease of maintenance, servicing, and ground handling at using echelon.	Yes	Comparable to similar type helicopter.
(55) Interchangeable and individually replaceable rotor blades.	Yes	
(56) Direct reading fluid level gauges wherever possible.	Yes	
(57) Reliable operation for extended periods under field conditions.	No	See paragraph 4e, part II, of report.
SECTION III - ASSOCIATE CONSIDERATIONS		
Associated equipment modification		
Temperature and heat.		
(58) This helicopter shall be capable of operation with-	No	See reference 7.

Required MC	UH-2A Meets MC's	Remarks
out ground support equipment from minus 25°F. to plus 115°F. OAT without modification.		
(59) A crew and cargo compartment heater system to provide an inside temperature of +40°F. with an outside temperature of -25°F. without winterization kit adaptation is required. These conditions must be met for air and ground operations within 10 minutes of initation.	Undetermined	
(60) Provisions for installation of a kit to make helicopter operable at temperatures from -25°F. to -65°F. OAT and to provide crew and cargo compartment temperatures of +40°F. These conditions must be met for air and ground operations within 30 minutes of initiation. An auxiliary power source may be used for starting.	Undetermined	
Storage		
(61) Provisions of AR 705-15 will be met.	Undetermined	
CBR and atomic		
(62) See Item 49.	Undetermined.	
Safety Considerations		
(63) Principles of human factors engineering will be applied in all aspects of design which influence the operation and maintemance of this aircraft.	Yes	See USAHUMRU report, appendix D.

Required MC	UH-2A Meet MC's	Remarks
(64) Mechanical vertical (sinusoidal) vibration of crew and passenger compartments shall not be lower than 10 cycles per second at 0.15 g intensity during conditions of minimum continuous power of the aircraft engine.	Undetermined	

b. Desired.

Desired MC	UH-2A Meets MC	Remarks
Performance		
(65) Maximum speed (V max), at least 135 knots.	Yes	However, attainable only at maximum military power which is limited to 30 minutes. At normal rated power, cruise airspeed is approximately 120 knots.
(66) Hover (out of ground effect, five minutes, 95^{o}F. at design gross weight)...6000 ft.	Undetermined	
(67) In addition to capabilities listed, this helicopter shall have the capability, under NASA standard conditions at sea level at design gross weight, of completing a 2.25-hour instrument flight with 45-minute fuel reserve. (Integral fuel tanks for 3-hour endurance at cruise speed.)	Yes	Estimated
(68) Stability and control, without use of electronic stabilization equipment to allow	Yes	

Desired MC	UH-2A Meets MC's	Remarks
maximum stability in cruise condition and maximum control in landing and takeoff. Stability in cruise should approach that of an airplane; design should permit maximum controllability at high-speed, low-level flight.		
(69) Helicopter should operate on all standard Army fuels and lubricants normally available in the combat zones.	Yes	Except grease (MIL 2164A) which is peculiar to the Navy usage.
(70) Aircraft stability and control, power supply, center of gravity travel limits and pilot and observer visibility shall be compatible with requirements of the armed helicopter weapons system.	Undetermined	
Materiel requirements		
Structure and design		
General.		
(71) Center of gravity location and landing gear design to facilitate return of helicopter to up-right position, when at rest or moving on landing surfaces, the vertical axis is tipped away from the vertical. This capability is required at empty and design gross weight; recovery after tipping the vertical axis up to 20^{o} is desired.	Yes	

Required MC	UH-2A Meets MC's	Remarks
(72) Provisions for installing ferry tanks to maximum cargo capacity.	No	Full internal and external fuel tanks, with crew of two brings gross weight to approximately 8800 pounds (maximum gross weight).
(73) Rotor blade anti-icing and/or deicing for moderate icing conditions.	Yes	Electrical system.
Crew station		
(74) General conference with latest revision of MIL Std. 250.	Undetermined	
(75) Crew compartment shall provide illumination levels where more than adequate vision is possible (a minimum of 20-foot Lamberts). Under "black-out" conditions, crew members will be provided with dim red lighting at an intensity of about 0.1 foot-Lamberts for vision under dark adaptation conditions.	Undetermined	
(76) A cargo floor with a standard tie down grid pattern.	Undetermined	
(77) Blackout provisions to isolate the troops compartment during night operations.	No	Not provided.
(78) Antennas on the bottom of the fuselage be flush-mounted.	Yes	

Desired MC	UH-2A Meets MC's	Remarks
Environmental protection		
(79) A minimum of one hour of fuel be protected from fire and leakage against caliber 30 small arms fire; weight of this protection shall be charged against basic aircraft weight.	No	Not provided.
(80) Crash resistant fuel cells.	No	Not provided.
(81) Design to minimize fire danger from effects of small arms weapons.	Undetermined	
(82) The enhancement of passive defense characteristics by reduction of infrared and radar reflectivity.	Undetermined	
(83) Noise levels should not exceed those specified in MIL-A-8806 (ASC), 25 October 1956, "Military Specification, Acoustical Noise Levels in Aircraft, General Specification for."	No	See appendix B.
Durability and reliability.		
(84) The helicopter will incorporate a minimum number of dynamic components, which will be of the simplest design with a minimum of maintenance and service requirements. All dynamic components will have a minimum service life of one thousand (1000) hours.	No	Similar service life as found on comparable Army helicopters.

Desired MC	UH-2A Meets MC's	Remarks
(85) Engine and other dynamic components shall not be materially affected by dust, sand, moisture, etc., encountered in operations from unprepared areas.	No	See desert test phase.

SECTION III - ASSOCIATE CONSIDERATIONS

Associated equipment modification

Temperature and heat.

Desired MC	UH-2A Meets MC's	Remarks
(86) Crew and cargo (troop) compartment ventilation system to provide an equivalent temperature index of 88°F. with outside temperature of plus 115°F.	Undetermined	
(87) Provisions for internal heating from an external source.	Undetermined	
(88) Heat distribution to preclude a cabin temperature spread in excess of 20°F.	Undetermined	
(89) Landing gear - provisions for special purpose gear.	Yes	See figure 1, appendix G.
(90) Hooded flight kit.	No	Not provided.

9. Aviation Safety. An evaluation of the operational safety, maintainability and crashworthiness was made by the US Army Board for Aviation Accident Research (USABAAR). Results are contained in appendix C.

10. Human Engineering. A human factors examination was made by the US Army Aviation Human Research Unit (USAAHUMRU). Results are contained in appendix D.

11. Deficiencies and Shortcomings.

a. Deficiency. The UH-2A does not meet all of the required characteristics listed in the MC's for a utility/tactical transport (see paragraph 8a above).

b. Shortcomings. The following shortcomings were determined during this evaluation:

(1) Lack of "flight idle" detent.

(2) Non-standard arrangement of instrument panel.

(3) Limited external night illumination.

(4) Lack of provisions for control of landing and searchlights by the copilot.

(5) Lack of control of the light intensity on the pilot's collective pitch lever switch control box.

(6) Operation of the "compressor pressure" caution light when retracting landing gear.

(7) Poor arrangement of troop seats in the cabin area.

(8) Lack of adequate external steps to facilitate ingress and egress from the helicopter.

(9) Lack of provisions for blackout of cabin area.

(10) Awkward location of the right auxiliary fuel tank filler cap.

(11) Poor readability of tail rotor gear box oil level sight gauge.

(12) Limited clearance in relation to cargo hook and extended main landing gear.

(13) Lack of visual reference to the external load on the cargo hook by the aircrew.

(14) Minimal flotation afforded by the small high pressure tires.

(15) Noise levels above those prescribed by Military Specifications.

(16) Provisions for aeromedical evacuation of only two litter patients.

(17) Excessive erosion of standard production blades (0.011 inch leading edge) under desert environmental conditions.

(18) Inadequate steps and hand-holds for servicing and maintenance of aft pylon.

(19) Inadequacy of the US Navy Flight Manual for Army use.

PART III - APPENDICES

Appendix		Page No.
A.	Report, US Airborne, and Special Warfare Board	55
B.	Report, US Army Aeromedical Research Unit	71
C.	Report, US Army Board for Aviation Accident Research	77
D.	Report, US Army Aviation Human Research Unit	81
E.	Engine Problem Evaluation	85
F.	Logistical Evaluation Data	89
G.	Retractable Landing Gear and Cutaway of Cabin in the Litter Configuration	111
H.	List of References	115

APPENDIX A

HEADQUARTERS
U. S. ARMY AIRBORNE, ELECTRONICS AND SPECIAL
WARFARE BOARD
Fort Bragg, North Carolina 28307

STEBF-AB 3963 4 October 1963

SUBJECT: Report of USATECOM Project Nr 4-3-1710-04 (AB 3963), "Military Potential Test of the UH-2A Aircraft"

TO: President
US Army Aviation Test Board
Fort Rucker, Alabama 32362

1. This letter transmits Military Potential Test final report, subject as above.

2. Test Results: The test item is a helicopter equipped with a single main rotor and retractable main landing gear. It is powered by a gas turbine engine with a rating of 1,250 horsepower. The test item is capable of carrying 11 passengers, in addition to a pilot and co-pilot, at a cruising speed of 134 knots. This Military Potential Test was conducted at Fort Bragg, N. C., during the period 20 - 22 August 1963. Internal and external air transport, static line drag tests, and dummy drop tests were conducted. In addition, 18 parachutists, with and without combat equipment, jumped from the test item. There are no known QMR's, SDR's, or technical characteristics specifications for this test item. No significant advantages for air drop and air transport of personnel, supplies, and equipment over standard Army helicopters already in the inventory are apparent. In the brief time available for test, no major deficiencies were revealed.

3. Conclusion: The UH-2A Helicopter has potential as a utility helicopter but offers no significant advantage for air drop and air transport of personnel, supplies, and equipment. Inadequate time was available for a complete test of its air delivery capabilities.

STEBF-AB 3963 4 October 1963
SUBJECT: Report of USATECOM Project Nr 4-3-1710-04 (AB 3963), "Military Potential Test of the UH-2A Aircraft"

4. Recommendations:

a. If a requirement exists in the Army for the UH-2A, recommend that engineer and service tests be conducted.

b. It is further recommended that this Board be allocated more time for testing in future evaluations of this type.

/s/ A. R. Brownfield
/t/ A. R. BROWNFIELD
Colonel, Artillery
President

1 Incl
as (in dupe)

Copy furnished:
CG, USATECOM, ATTN:
AMSTE-BG, APG, Md 21005

HEADQUARTERS
U. S. ARMY AIRBORNE, ELECTRONICS AND SPECIAL
WARFARE BOARD
Fort Bragg, North Carolina 28307

4 October 1963

REPORT OF USATECOM PROJECT NR 4-3-1710-04 (AB 3963)

"MILITARY POTENTIAL TEST OF THE UH-2A AIRCRAFT"

(20 - 22 August 1963)

PART I - GENERAL

A. References:

1. Letter, AMSTE-BG, USATECOM, 30 July 1963, subject: "Test of UH-2A Aircraft."

2. TWX, STEBF-AB, USAAESW Board, 15 August 1963 (Outline Plan of Test).

B. Authority:

1. Directive: Letter, AMSTE-BG, USATECOM, 30 July 1963, subject: "Test of UH-2A Aircraft."

2. Purpose of Test: Determine the Military Potential of the UH-2A Helicopter for air drop and air transport of personnel, supplies, and equipment.

C. Description of Materiel: The test item is a helicopter equipped with a single main rotor and retractable main landing gear. It is powered by a gas turbine engine with a rating of 1,250 horsepower. The test item is capable of carrying 11 passengers, in addition to a pilot and copilot, at a cruising speed of 134 knots. The test item's cargo compartment is 113" long on the right side, 96" long on the left side, 55" high, and 45" wide. The main cargo compartment door (50" high x 48" wide) is located on the left side of the test item. The cargo compartment rescue door (50" high x 33" wide) is located on the right side of the test item.

D. Background: The test item was originally developed by the US Navy to be used in an air-sea rescue role. The US Navy provided the test item to the US Army, on a loan basis, for test purposes. The first of these aircraft has been delivered to the Aviation Test Board for test. The second aircraft is to be modified for installation of helicopter armament systems and will be tested at a later date. USATECOM directed that the first UH-2A Aircraft be tested in the Army environment by the US Army Aviation Test Board to determine operational performance and data on maintenance and parts usage. On 30 July 1963, USATECOM forwarded a copy of the "Directive for Military Potential Test of UH-2A Aircraft" to this Board and assigned this Board as a Participating Test Agency.

E. Test Objectives: Same as B 2, above.

F. Findings: No known QMR's, SDR's, or technical characteristics specifications exist for this test item.

G. Conclusion: The UH-2A Helicopter has potential as a utility helicopter but offers no significant advantage for air drop and air transport of personnel, supplies, and equipment. Inadequate time was available for a complete test of its air delivery capabilities. Safety hazards exist in the position of the cargo hook in relation to the landing gear, lack of a rear view mirror for the pilot to observe hook-up of external loads, and in the tail wheel constituting an obstruction to deploying personnel parachutes (T-10).

H. Recommendations:

1. If a requirement exists in the Army for the UH-2A, recommend that engineer and service tests be conducted.

2. It is further recommended that this Board be allocated more time for testing in future evaluations of this type.

/s/ A. R. Brownfield
/t/ A. R. BROWNFIELD
Colonel, Artillery
President

PART II - TEST DATA

REPORT OF USATECOM PROJECT NR 4-3-1710-04 (AB 3963)

This military potential test was conducted by Captain James A. McMillen and other members of this Board during period 20 - 22 August 1963.

1. Test Nr 1

a. Purpose: Determine the physical characteristics of the test item with respect to air delivery.

b. Method: The test item was measured and examined. Technical data were reviewed.

c. Results:

(1) The cargo compartment of the test item is 113" long on the right side, 96" long on the left side, 55" high, and 45" wide (Annex C.1). The main cargo compartment door (50" high x 48" wide) is located on the left side of the test item (Annexes C.1 and C.2). The cargo compartment rescue door (50" high x 33" wide) is located on the right side of the test item (Annexes C.1 and C.2).

(2) The test item is equipped with two anchor line assemblies above each door inside the cargo compartment, but is not equipped with jump lights or an emergency bell.

(3) The test item does not have a suitable point near the cargo hook to attach a static line for external air drop (Annex C.3).

2. Test Nr 2

a. Purpose: Determine the military potential of the test item for internal transport of troops, supplies, and equipment.

b. Method:

(1) Internal transport facilities were examined. Technical data were reviewed.

(2) Personnel, supplies, and equipment were loaded, restrained, flown, and unloaded.

c. Results:

(1) The tiedown fittings in the floor of the cargo compartment are rated by the manufacturer at 500 pounds horizontal, 1,250 pounds at 30 degrees, and 1,600 pounds vertical.

(2) No problems were encountered with the following loads:

(a) Twenty-four cases of "C" rations (912 pounds) (Annex C.3).

(b) Eight passengers. (Remaining available seats were not utilized so that best performance of the test item could be realized.)

(c) Two litter patients and eight passengers (aeromedical evacuation configuration) (Annex C.4).

3. Test Nr 3

a. Purpose: Determine the military potential of the test item for external transport of supplies and equipment.

b. Method:

(1) Facilities for external hook-up were examined. Technical data were reviewed.

(2) Three representative loads were lifted externally.

(3) A Truck, Utility, 1/4-Ton, 4x4, M38A1, and 1/4-ton trailer were rigged for external transport.

c. Results:

(1) The external cargo hook (Annex C.3) is rated by the manufacturer at 4,000 pounds and is located close to the bottom of the test item. A safety hazard exists in that the pilot has no rear view mirror to observe the hook, and the hook-up crew must exercise caution not be become lodged between the load and landing gear.

(2) No problems were encountered with the following loads:

Load Nr	Item	Weight (Lbs)	Annex
1	27 cases "C" rations in external cargo net	1,026	C.4
2	52 cases "C" rations in external cargo net	1,976	C.4
3	Truck, Utility, 1/4-Ton, 4x4, M38A1	2,630	C.4

(3) The test item could not lift the Truck, Utility, 1/4-Ton, 4x4, M38A1, and 1/4-ton trailer (3,200 pounds).

4. Test Nr 4

a. Purpose: Determine the military potential of the test item for safe air drop of personnel.

b. Method: The following were evaluated in actual tests with motion pictures taken and studied:

(1) Static line drag characteristics outside the test item and retrieval of static lines into the test item at indicated air speeds of 70 to 90 knots.

(2) Exit, drop, and subsequent deployment of personnel parachutes (T-10) on dummies at indicated air speeds of 70 to 90 knots.

(3) Safe exit of a single parachutist and subsequent deployment of the T-10 parachute at indicated air speed of 80 knots, and at an altitude of 2,000 feet.

(4) Safe exit of the maximum number of parachutists, with and without combat equipment, and subsequent deployment of the T-10 parachute at indicated air speed of 80 knots, and at an altitude of 1,500 feet.

c. Results:

(1) No difficulties were encountered in trailing and retrieving static lines. The static lines trailed horizontally along the side of the

test item and inflicted no damage to the test item. The test item was placed in autorotation with a short (32") static line trailing. The static line rose in a vertical plane and was not deployed further due to safety considerations.

(2) It was noted and recorded on film that 11 dummies fell safely, and that the parachute canopies deployed normally with no interference with the test item.

(3) Difficulties were encountered with parachutists jumping from the test item. On the fourth of four passes, the parachute canopy caught on the test item's tail wheel, and a 7" x 6" hole was torn in the canopy.

(4) All jumps were performed utilizing the main cargo compartment door on the left side of the test item. A step was installed, by the manufacturer, in place of auxiliary fuel tanks which aided getting into the test item while wearing a parachute and equipment (Annex C.5).

(5) It was determined that six parachutists, with or without equipment, were the maximum number that could be safely seated and jumped from the test item. The personnel seats in the test item are 16 1/2" wide by 14 1/4" deep and are too small for parachutists with equipment.

(6) Procedures and techniques developed during the test are on file at this Board.

5. Test Nr 5

a. Purpose: Determine the military potential of the test item for air drop of supplies.

b. Method:

(1) Four representative loads were air dropped from the cargo compartment of the test item at an indicated air speed of 80 knots and at an altitude of 1,500'.

(2) Four representative loads were air dropped from the test item's cargo hook at an indicated air speed of 80 knots and at an altitude of 1,500'.

c. Results:

(1) No difficulties were encountered with the following internal loads (Annex C.6):

Load Nr	Weight (Lbs)	Container	Parachute
1	300	A-7A	G-13
2	300	A-7A	G-13
3	300	A-7A	G-13
4	300	A-7A	G-13

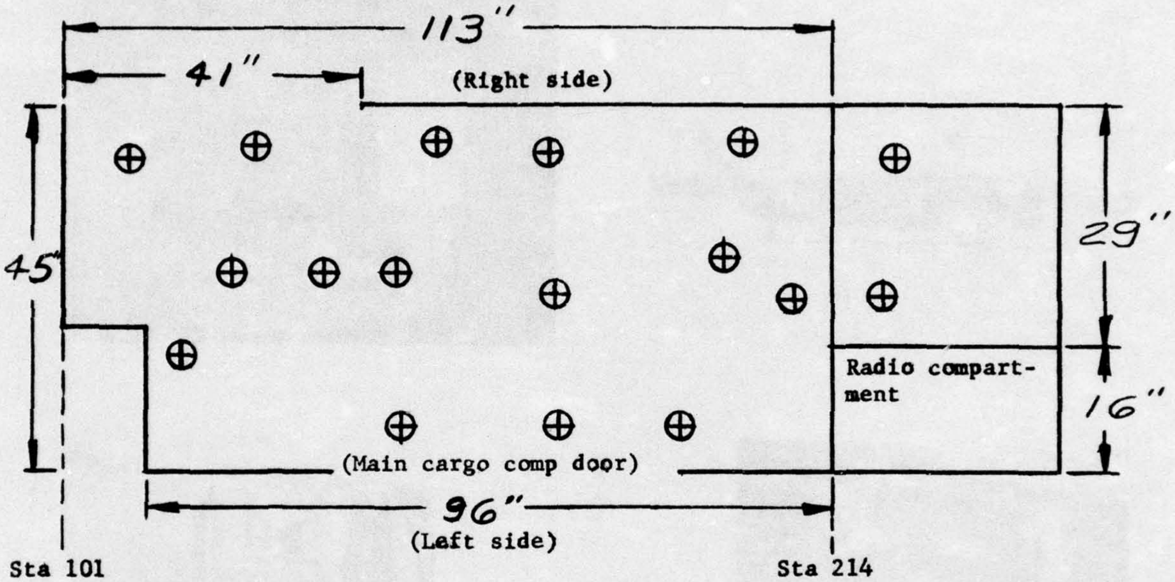
(2) *Difficulties were encountered (as indicated) with the* following external loads:

Load Nr	Weight (Lbs)	Parachute	Remarks
1	500	G-13	Static line broke before parachute deployed.
2	1,000	G-12	Successful.
3	2,000	G-12	Parachute did not fully deploy.
4	2,200	G-12	Successful.

PART III - ANNEXES

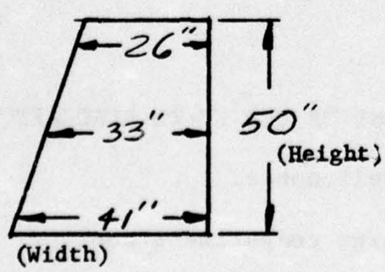
REPORT OF USATECOM PROJECT NR 4-3-1710-04 (AB 3963)

DIAGRAM CARGO COMPARTMENT:

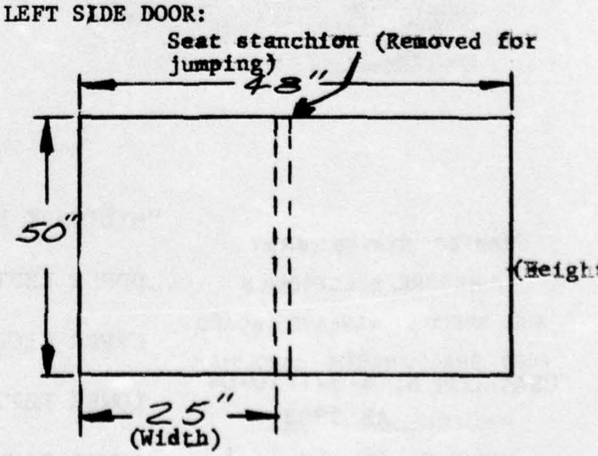


Cargo compartment is 55" high.
Cargo floor will support 200 lbs per sq ft.
⊕ Tiedown fittings: 1,250 lbs (30 degrees).

RIGHT SIDE DOOR (CARGO COMPARTMENT RESCUE DOOR):



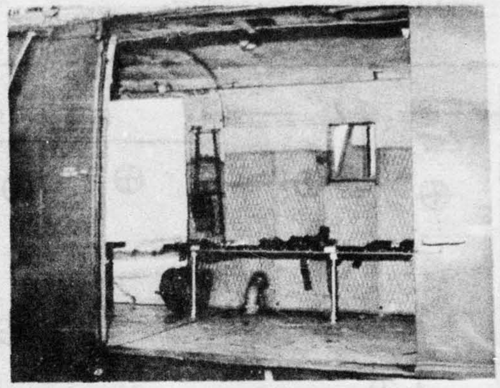
LEFT SIDE DOOR:

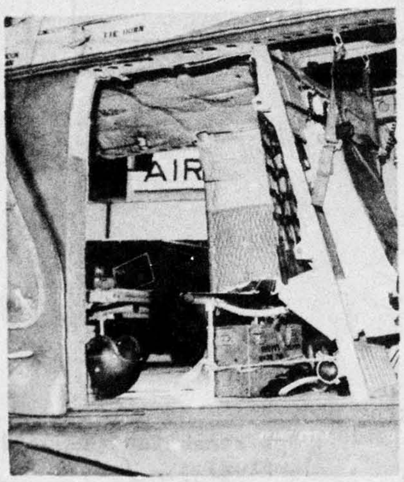


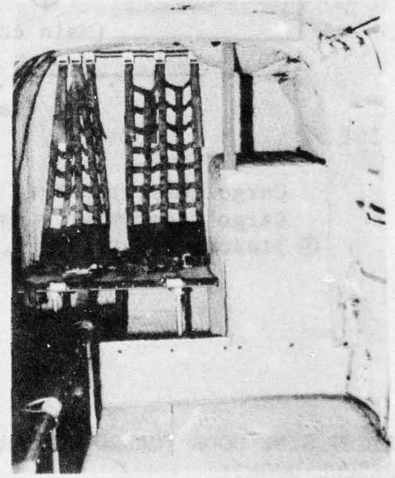
USATECOM Nr 4-3-1710-04
PROJECT AB 3963
ANNEX C.1

III.2

"MILITARY POTENTIAL TEST OF THE UH-2A AIRCRAFT"







"MILITARY POTENTIAL TEST OF THE UH-2A AIRCRAFT"

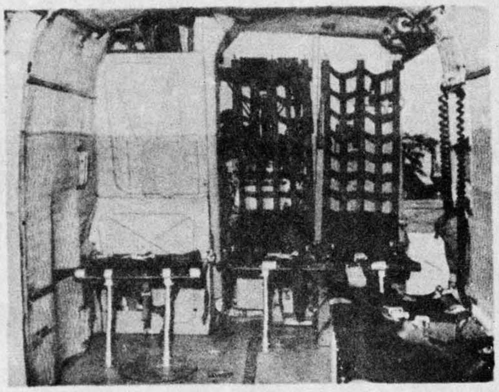
UPPER LEFT - UH-2A Helicopter.

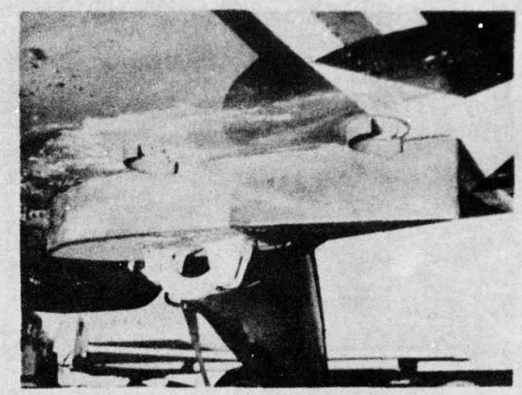
UPPER RIGHT - Main cargo compartment door.

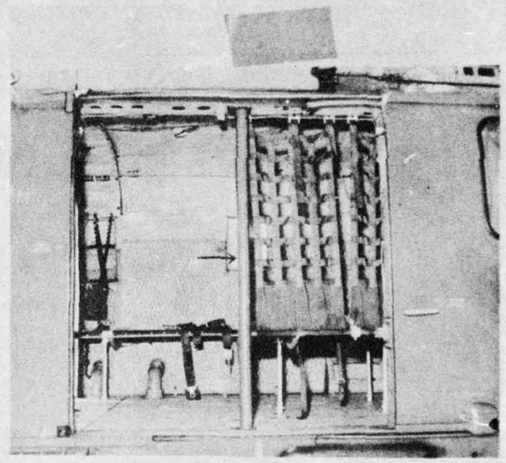
LOWER LEFT - Cargo compartment rescue door.

LOWER RIGHT - Interior of cargo compartment looking rearward.

UNITED STATES ARMY
AIRBORNE, ELECTRONICS
AND SPECIAL WARFARE BOARD
FORT BRAGG, NORTH CAROLINA
USATECOM Nr 4-3-1710-04
PROJECT AB 3963
NEGATIVE 15, 5, 2, 1
ANNEX C.2
III.3







"MILITARY POTENTIAL TEST OF THE UH-2A AIRCRAFT"

UPPER LEFT - Interior of cargo compartment looking forward.

UPPER RIGHT - Cargo hook on bottom of test item.

LOWER LEFT - 24 cases of "C" rations (912 pounds) restrained for 4 G's forward and 2 G's aft.

LOWER RIGHT - Arrow shows stanchion that was removed for tests.

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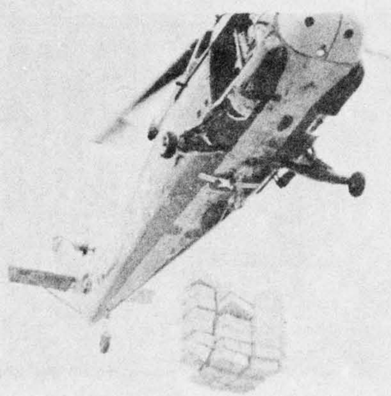
AND SPECIAL WARFARE BOARD
FORT BRAGG, NORTH CAROLINA
USATECOM Nr 4-3-1710-04
PROJECT AB 3963
NEGATIVE 7, 10, 8, 32
ANNEX C.3
III.4



"MILITARY POTENTIAL TEST OF THE UH-2A **AIRCRAFT**"

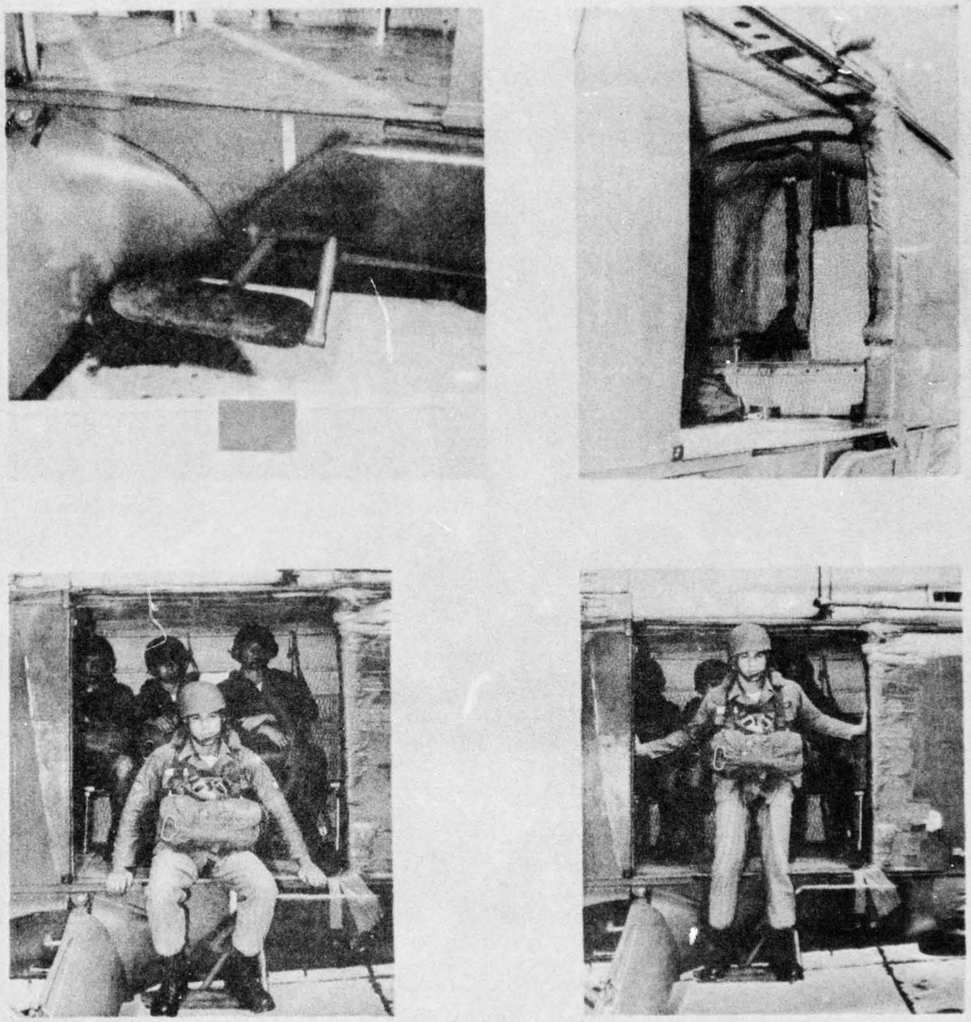
UPPER LEFT - Test item configured for aero-medical evacuation utilization.

UPPER RIGHT - External air transport of 27 cases "C" rations (1,026 pounds).

LOWER LEFT - External air transport of 52 cases "C" rations (1,976 pounds).

LOWER RIGHT - External air transport of Truck, Utility ¼-Ton, 4x4, M38A1 (2,630 pounds).

UNITED STATES ARMY
AIRBORNE, ELECTRONICS
AND SPECIAL WARFARE BOARD
FORT BRAGG, NORTH CAROLINA
USATECOM Nr 4-3-1710-04
PROJECT AB 3963
NEGATIVE 33, 12A, 17A, 18A
ANNEX C.4
III.5



"MILITARY POTENTIAL TEST OF THE UH-2A AIRCRAFT"

UNITED STATES ARMY
AIRBORNE, ELECTRONICS
AND SPECIAL WARFARE BOARD
FORT BRAGG, NORTH CAROLINA
USATECOM Nr 4-3-1710-04

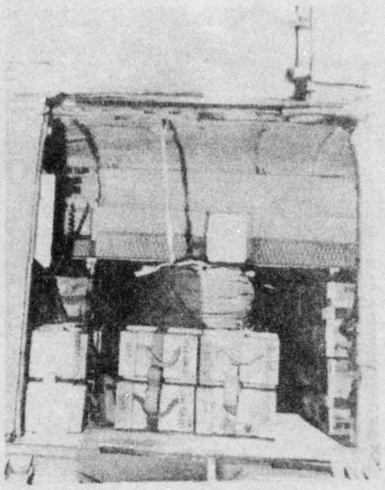
PROJECT AB 3963
NEGATIVE 11,13,19,17
ANNEX C.5
III.6

UPPER LEFT - Step installed on left side of test item below main cargo door.

UPPER RIGHT - Main cargo door removed and edge of door padded and taped for jumping.

LOWER LEFT - Parachutist sitting in door.

LOWER RIGHT - Parachutist standing on step prior to exiting.



UNITED STATES ARMY
AIRBORNE, ELECTRONICS
AND SPECIAL WARFARE BOARD
FORT BRAGG, NORTH CAROLINA
USATECOM Nr 4-3-1710-04
PROJECT AB 3963
NEGATIVE 20, 9A
ANNEX C.6
III.7

"MILITARY POTENTIAL TEST OF THE UH-2A AIRCRAFT"

UPPER LEFT - Internal air drop load prior to dropping (300 pounds).

UPPER RIGHT - External air drop, hook-up man fastening breakaway static line to step.

LOWER CENTER - External air drop load

APPENDIX B

Aviation Field Operations Division
U. S. ARMY AEROMEDICAL RESEARCH UNIT
Fort Rucker, Alabama 36362

USAARU-FO 29 July 1963

NOISE EVALUATION OF THE KAMAN UH-2A

1. Methods and Equipment.

a. Due to the number of aircraft to be tested and the short time available for testing, the noise analysis was limited to the following:

"A" 24-55 db: sound level for speech interference.

"B" 55-85 db: sound level for noise survey.

"C" 85-140 db: sound pressure level, over-all frequency response.

b. A Sound-Level-Meter, General Radio, type 1551-C, was used for the noise measurement.

c. The test area, located at County Line Strip, is a pre-marked circle with a radius of 50 feet divided into 30^{o} segments.

2. Results. (See Annex A)

3. Discussion.

	Doors On	Doors Off	MIL-A-8806
Normal cruise	110	115	106
Maximum cruise	110	115	113

a. Operation of this helicopter at normal or maximum cruise with the doors off produced an excessive sound pressure level of 115 decibels, which exceeds Tables I and IV MIL-A-8806.

b. There are no military specifications for external noise. Raw data is included for purpose of comparison only.

4. Summary. Improvements should be made to reduce noise levels to meet military specifications (MIL-A-8806).

1 Incl
as

WILLIAM C. THRASHER
2/Lt., MSC
Ass't Chief, Avn Fld Opns Div

NOISE LEVEL MEASUREMENTS-OCTAVE BAND ANALYSIS
DATA COLLECTION SHEET

Analyzed by Lt. Thrasher Date 1 July 1963

KAMAN UH-2A

DOORS-ON	A	B	C	Center	Student	Air Speed	Lbs Torque Manifold	RPM	Radius
Ground idle	90	91	95		x		opsi	40%	
Ground high power	101	102	103		x		14	92%	
Hover	100	102	108		x		61	100%	
Normal cruise	99	101	110		x	115	48	100%	
Maximum cruise	99	101	110		x	115	48	100%	
Aft compartment-floor level below engine	100	104	108	measured at maximum cruise					
DOORS-OFF									
Ground Idle	91	91	93		x		opsi	40%	
Ground high power	105	105	105		x		14	92%	
Hover	102	105	109		x		61	100%	
Normal cruise	108	114	115		x	115	48	100%	
Maximum cruise	108	114	115		x	115	48	100%	
EXT HIGH POWER							13psi	92%	
0	93	95	98	210	95 98	100			50'
30	96	96	98	240	94 96	100			"
60	97	97	100	270	95 97	100			"
90	101	103	102	300	94 97	99			"
120	100	101	103	330	94 96	100			"
150	94	99	101						"
180	93	96	100						"
HOVER							61psi	100%	
0	96	98	104	210	98 101	104			100'
30	97	100	102	240	103 103	104			"
60	95	97	100	270	94 99	101			"
90	94	97	100	300	96 100	107			"
120	97	100	102	330	98 98	103			"
150	96	101	104						"
180	98	102	109						"

Annex A

Aviation Field Operations Division
U. S. ARMY AEROMEDICAL RESEARCH UNIT
Fort Rucker, Alabama

USAARU-FO 5 July 1963

REPORT ON KAMAN UH-2A

1. Method of Testing.

a. The heating and ventilation evaluation of the Kaman UH-2A model consisted of comparisons of outside air temperature and cockpit air temperature with the aircraft under all operating conditions. In conjunction with these checks, a carbon monoxide test was also done.

b. Equipment consisted of:

(1) Weston Aneroid Thermometer, Model 2291.

(2) Mine Safety Appliance Company Carbon Monoxide Tester, Category No. DS-47133.

2. Results. (See Annex A)

3. Discussion.

a. The recommended maximum temperatures for clothed men not especially acclimatized are as follows:

(1) Resting in still air - 88°F.

(2) Resting, with some air movement (170 FPM air velocity) - 93°F.

(3) Moderate work, still air - 78°F.

Reference: Patty, Frank A., Industrial Hygiene & Toxicology (2d ed., Vol. 1; New York: Interscience Publishers Inc., 1958).

b. The Kaman UH-2A model helicopter meets the above requirements adequately with the exception of one condition--with the doors on, windows closed, and vents closed, cockpit and cargo compartment temperatures rose to 94°F. (See Annex A).

USAARU-FO 5 July 1963
SUBJECT: Report on Kaman UH-2A

c. Although a temperature of 94°F. was encountered under conditions noted above, it is felt that aircraft will seldom be operated under those conditions with existing outside temperatures in the 90°F. range.

d. No carbon monoxide was found in this aircraft under all operating conditions.

e. A heater was not installed on this aircraft.

/s/ J. C. Rothwell
/t/ J. C. ROTHWELL
Captain, MSC
Ass't Chief, Avn Fld Opns Div

1 Incl
as

KAMAN UH-2A

HEATING AND VENTILATION EVALUATION OF OFF-THE-SHELF HELICOPTER TRAINERS

Analyzed by Capt Rothwell Date 1 July 1963

	% CO A/C	% CO Out	Temp A/C	Temp Out
VENTILATION				
On Ground				
Doors On - Window Open	0		86°F	82°F
Doors On - Window Closed, Vent Open	0		88°F	82°F
Doors On - Window Closed, Vent Closed	0		94°F	82°F
Hover				
Doors On - Window Open	0		86°F	82°F
Doors On - Window Closed, Vent Open	0		88°F	82°F
Doors On - Window Closed, Vent Closed	0		92°F	82°F
In-Flight				
Doors On - Window Open	0		86°F	80°F
Doors On - Window Closed, Vent Open	0		90°F	80°F
Doors On - Window Closed, Vent Closed	0		93°F	80°F

HEATING*

*Heater not present on this aircraft.

ANNEX "A"

APPENDIX C

HEADQUARTERS
DEPARTMENT OF THE ARMY
Office of the Deputy Chief of Staff for Military Operations
Board for Aviation Accident Research
Fort Rucker, Alabama

BAAR-E 16 July 1963

SUBJECT: USABAAR KAMAN UH-2A Off-the-Shelf Evaluation

TO: President
U. S. Army Aviation Test Board
ATTN: Off-the-Shelf Project Officer
Fort Rucker, Alabama

1. The following is USABAAR's evaluation of the KAMAN UH-2A entry for the off-the-shelf weapons platform. The evaluation considered the aspects of aviation safety and accident prevention in three primary categories. In each of these elements, USABAAR found the aircraft to be acceptable for its intended mission. However, there are certain deficiencies which will detract from its mission capability and should be considered by those responsible for selecting the winner of the competition. Categories considered are:

a. Operational Safety - This category considers those features of the aircraft and its operating characteristics that are considered to be conducive to accident causation and which may detract from the operator's ability to maintain safe flight at all times.

b. Maintainability - This category considers maintenance design features of the aircraft contributing to accident causation. It includes those features of "Murphy's Law", ease of inspection, accessibility for component replacement, the preflight inspections imposed on the operator, etc.

BAAR-E 16 July 1963
SUBJECT: USABAAR KAMAN UH-2A Off-the-Shelf Evaluation

c. Crashworthiness - This category considers design features of the aircraft that, in the event of a crash, provide protection to the occupants from injury. It also includes features of crash-fire worthiness.

2. Evaluation comments are as follows:

a. Operational Safety

(1) There is a possibility that the auxiliary fuel drop tanks would interfere with troops and/or crew members when exiting aircraft from left side of cargo compartment when tanks are installed.

(2) Retractable landing gear is of doubtful value for Army use.

b. Maintainability

(1) It is commendable to KAMAN in noting they have installed eight separate pick-up points in engine, transmission, and gear boxes as magnetic plug readouts for chip detection. Two warning lights are used; one for engine chip detectors and another for transmission detectors.

(2) Mechanical linkages, proturbances, etc., are extremely involved and quite probably susceptible to maintenance problems.

(3) Blade folding (with the penalty of added gadgetry) worth is of doubtful value to the Army.

(4) No hand hold is provided on the aft pylon to enable safe access to inspect tail rotor gear box, rotor head and blades.

c. Crashworthiness

(1) Occupants of the two forward aft-facing troop seats straddle a horizontal bar when seated. Only the fabric's tautness prevents bottoming against the tubular cross bar. The injury potential of this type of installation is obvious.

BAAR-E 16 July 1963
SUBJECT: USABAAR KAMAN UH-2A Off-the-Shelf Evaluation

(2) The forward attachment of the seat belt of the two side troop seats is limited in its lateral travel. Other attachments are swivel mounted; these two are not. Limited lateral reduces the attachment's ability to absorb lateral loads.

(3) The static line is mounted and guided by assemblies that are lethal injury producers. They project and the corners are rather sharp.

(4) The left forward litter brackets project with sharp corners. The occupant left forward aft-facing troop seat is most likely to receive injury from them.

(5) A similar type of installation is found on each side of the pedal adjustment screw in the cockpit.

(6) Through inquiry USABAAR was unable to determine the material used in the seat pan cushion. It felt to be some material other than ensolite; more like sponge rubber.

3. The controllability and stability during flight is excellent and should be recognized as a desirable feature worthy of mention.

/s/ Robert M. Hamilton
/t/ ROBERT M. HAMILTON
Colonel, Infantry
Director, USABAAR

APPENDIX D

U. S. ARMY AVIATION HUMAN RESEARCH UNIT
Fort Rucker, Alabama

16 August 1963

Human Factors Examination of the UH-2A Helicopter.

1. Summary

1.1 From the human factors standpoint the UH-2A helicopter is regarded as decidedly superior to any other Army aircraft in cockpit design, and slightly above average in design for maintainability. The design is considered to have shortcomings with respect to Army operational requirements for handling loads, and ingress and egress of crew and passengers.

2. Detailed Considerations

2.1 Based on replies to questions posed, the helicopter is considered to have generally good handling qualities combined with low vibration levels. This should result in somewhat less crew and passenger fatigue than is experienced with present helicopters. The small forward tilt during cruising flight should materially improve passenger comfort on long duration flights over that of more tilted helicopters.

2.2 Access to the cockpit is relatively poor from either the ground or from the passenger compartment.

2.3 Access to the passenger-cargo compartment is less than desirable.

2.4 The dimensions and arrangement of the passenger-cargo compartment are not well suited to Army requirements.

2.4.1 Many long objects could not be placed so as to extend out both sides of the compartment due to the unsymmetrical door arrangement.

2.4.2 The vertical dimensions of the compartment and doors are minimal, and should pose difficulties in rapid loading and particularly unloading of troops.

2.5 There is evidence that maintainability was given adequate consideration in the design of the helicopter. It appears somewhat superior to other recently acquired Army helicopters in maintenance requirements and in access to components.

2.6 The cockpit is regarded as decidedly superior to any other Army aircraft. This opinion is based on evidence of a conservative application of accepted human factors principles which have been completely lacking in any other Army aircraft.

2.6.1 Desirable features which are not found on other Army aircraft include:

2.6.1.1 An alignment of pointers of power plant status indicators which permits monitoring them for satisfactory status without the requirement for checking each indicator individually.

2.6.1.2 Using a single scale labeled "Percent RPM" for both engine and rotor RPM, rather than separate scales labeled in actual RPM as used on other Army helicopters. The "Percent RPM" presentation provides all required information in a form which is more easily interpreted and applied.

2.6.1.3 The normal position of the Percent RPM needles is at the nine o'clock position and in alignment with other engine monitor instruments, thus permitting this indicator, under most normal conditions, to also be scanned for alignment rather than actually having to read it.

2.6.1.4 A fuel quantity gage which accurately and rapidly provides both total and individual tank fuel quantity.

2.6.1.5 A large surface between the windshield and the rear edge of the glare shield which can be used (although not intentionally designed for this purpose) for keeping maps or other charts which must be referred to during flight. In this location the maps or charts may be referred to without the full diversion of attention inside the cockpit which is required for reference to kneeboard-held maps or charts. This feature is a distinct advantage during very low altitude flying and during some types of approaches.

2.6.2 There was excessive parallax involved in reading some of the instruments, particularly the exhaust gas temperature indicator.

2.6.3 Although decidedly superior to any other Army aircraft, the cockpit design needs considerable improvement before it will adequately provide the information requirements for routine operation in the Army tactical environment.

/s/ Robert H. Wright
/t/ ROBERT H. WRIGHT, Ph. D.
Research Scientist

STATOR VANE OPERATING SCHEDULE

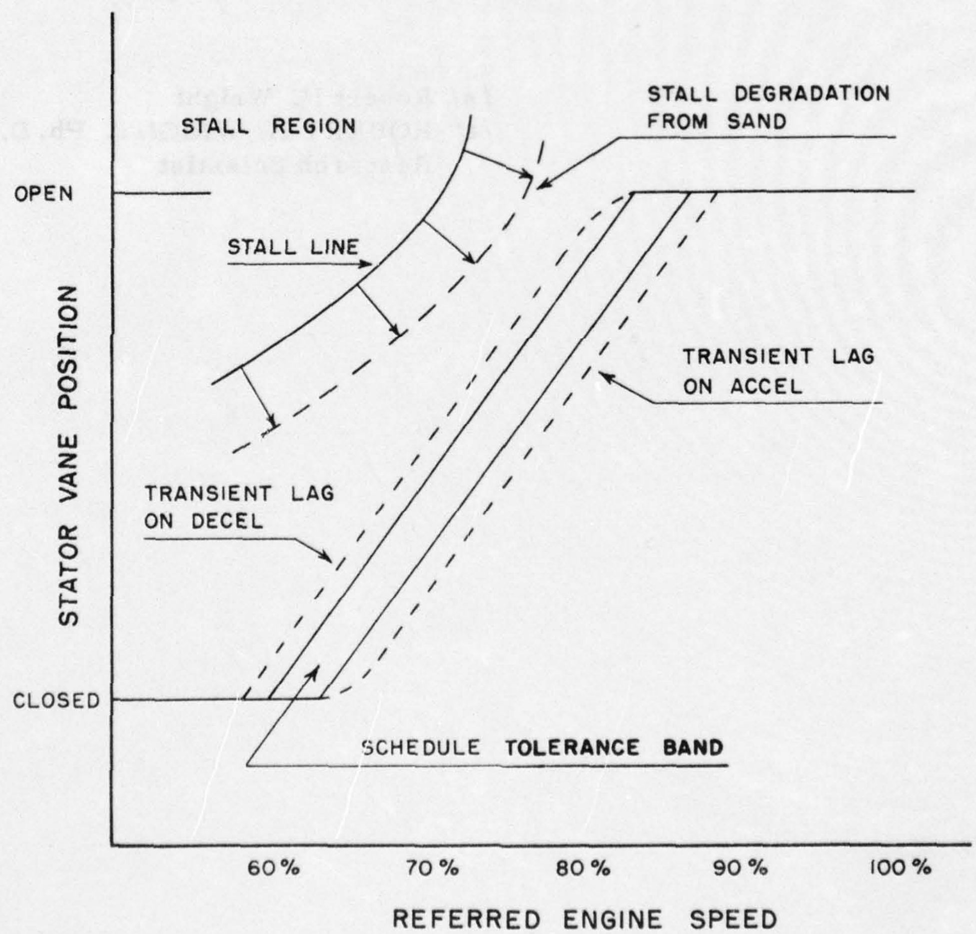


Figure 16

APPENDIX E

ENGINE PROBLEM EVALUATION

During the desert test of the UH-2A Helicopter in July 1963, an engine operational problem was discovered, requiring the replacement of two engines. Compressor stall was encountered during engine deceleration. Two stalls were experienced on engine S/N 270388 and one on engine S/N 270609. These stalls occurred following reduction of the power/pitch control, when the engine-gas-producer speed decelerated to approximately 85-percent speed, and were characterized by audible sounds, high exhaust gas temperature, and an unexplainable loss of engine oil pressure.

Engine S/N 270609 had been installed in the test helicopter during the portion of the test conducted at Fort Rucker and had accumulated a total of 73.8 hours of operation prior to the start of the desert test. The deceleration stall of this engine occurred after 8.25 hours of desert operation. Helicopter operation during this time included 10 takeoffs and landings. This engine was removed from the test helicopter and returned to the manufacturer for investigation.

Engine S/N 270388 was installed in the test helicopter following removal of engine S/N 270609. Engine S/N 270388 had a total of 2.7 hours of operation at time of installation. The first deceleration stall occurred at 30.3 engine hours. Helicopter operation during this time included 105 takeoffs and landings. Based on the results of the investigation conducted on engine S/N 270609, the variable stator scheduling (speed at which variable stators begin to close on deceleration) was up speeded approximately 0.6 percent. Stall checks were conducted and engine operation was determined to be stall free. Following this maintenance, the test was resumed.

The second deceleration stall occurred on this engine 14.4 hours later at 44.7 engine hours. Inspection of the engine revealed that the leading edges of the first and second stages of compressor blades were burred. The damaged blades were stoned to remove the burring; the engine reassembled and operationally checked. The engine operation was found to be stall free; however, this engine was removed and engine S/N 270385 was installed to continue the test. Engine S/N 270385

was used for approximately 6.0 hours of desert testing and then for the high elevation tests. No deceleration stalls were experienced with this engine.

The deceleration stall problem experienced on engines S/N 270609 and 270388 was caused by deterioration of compressor performance. This performance degradation resulted from the ingestion of sand which caused burring of the leading edges of the initial stages of compressor blades. Contributing to this problem on engine S/N 270609 was the variable stator schedule which was determined to be on the low side of the normal schedule tolerance band.

The T58-GE-8B engine utilizes variable compressor entrance guide vanes and variable compressor stator vanes through the first three stages. Use of this system is a method of obtaining stall-free compressor operation, as is compressor bleeding (release of controlled amounts of compressed air to the atmosphere), during mid-speed engine acceleration. Both methods also contribute to ease of starting by limiting the amount of compressed air furnished to the combustor resulting in a richer fuel/air ratio during starts.

During start and low-speed operation of the T58-CE-8B engine the variable entrance guide vanes and the first three stages of compressor stators remain in a relatively closed position, limiting the amount of air flow through the compressor. During engine acceleration and at approximately 60 percent referred compressor speed, the variable entrance guide vanes and compressor stator vanes begin to open allowing passage of a larger amount of air through the compressor. As the engine continues to accelerate in speed the guide vanes and stator vanes continue to open until approximately 85 percent referred compressor speed is reached at which time they are at their "full open" position. They remain in this position during all engine operation above approximately 85-percent referred compressor speed. Angular change of the guide vanes and stator vanes from the closed to open position is 32 degrees, and the motition of all the vanes is simultaneously controlled by a single actuator and the necessary mechanical linkage.

During production of the engine, the identical stator vane operating schedule is not maintained from one engine to the next, but a schedule tolerance band is maintained. This requires that the stator vanes of all engines begin to open between 58.6 percent and 62.0 percent referred compressor speed, and reach the fully open position between 83.5- and 87.0-percent referred compressor speed. Previous engine operating

experience indicated that this schedule tolerance band was adequate for those conditions normally encountered by T53-GE-8B engines.

As was previously mentioned, the variable stator schedule for engine S/N 270609 was on the low side of the normal tolerance band contributing to the deceleration stall problem. By referring to figure 16 it can be seen that an engine whose stator vane operating schedule is on the low speed side of the tolerance band is operating closer to the normal stall line of the engine. As deterioration of compressor performance occurs, the stall line of the engine progresses to a point where compressor stalls can be encountered at higher referred engine speeds reducing the stall margin. Under transient engine operating conditions the stator operating schedule line is shifted lower (speed wise) during engine deceleration, reducing further the margin between the engine stall line and the stator operating schedule line. A stall of the compressor occurs when those conditions exist which are illustrated by the intersection of stator vane operating schedule line and the engine stall line.

Relative to engine S/N 270609 which was found to have a stator vane operating schedule on the low speed side, combined with the transient lag effect during deceleration and compressor degradation due to sand ingestion, a deceleration stall occurred very soon (8.25 hours) after desert operation was initiated. Relative to engine S/N 270388, the stator vane operating schedule was known to be near the middle of the stator vane operating schedule tolerance band and a deceleration stall was not encountered with this engine until 30.3 hours of desert operation had been accumulated.

Although the stator vane operating schedule can contribute to a stall of the engine, the primary cause of the problem was due to compressor performance degradation due to burring of the compressor blades caused by sand ingestion.

Based on the experience gained from engines S/N 270609 and 270388 and by assuming that (a) the relative position of the stall line of these two engines is typical of other T58-GE-8B engines, (b) an engine with the greatest available stall margin is installed, and (c) conditions similar to those experienced during the desert test exist, it is believed that a maximum of 50-75 hours of stall-free operation can be expected.

Additional stall-free operation could be obtained; however, disassembly of the engine and stoning of the compressor blades would be

required. This type of maintenance is normally accomplished at field maintenance levels.

As a result of the desert test experience the manufacturer had developed a special test item which could be used by crews operating in desert conditions to perform deceleration stall margin checks at specified frequencies. Stall free operation of the engine could be assumed to exist for some as yet undetermined amount of operating time, if by use of this test item the engine was found to be stall free. Further, the manufacturer is presently investigating the feasibility of raising to a higher speed the stator vane operating schedule tolerance band. If this is feasible, then the margin between the engine stall line and the stator vane operating schedule line could be increased to some degree.

APPENDIX F

LOGISTICAL EVALUATION DATA

SECTION ONE

COMPONENT LIST

UH-2A

Nomenclature	Time Between Overhaul (TBO)
Azimuth Assembly 6-48	240
Rotor Blade A1-475	600
Rotor Blade A1-482	600
Rotor Blade A1-473	600
Rotor Blade A1-371	600
Tail Rotor Blade and Grip 336	240
Tail Rotor Blade and Grip 350	240
Tail Rotor Blade and Grip 337	240
Folding Pin Bracket 6-190	1000
Folding Pin Bracket 6-157	1000
Folding Pin Bracket 6-166	1000
Folding Pin Bracket 6-269A	1000
Main D/S Bearing 88A	500
Tail Rotor Bearing Retainer 116	500
Tail Rotor Bearing Retainer 107	500
Tail Rotor Bearing Retainer 24	500

Nomenclature	Time Between Overhaul (TBO)
Blower Assembly 123	500
M/R Damper 770	500
M/R Damper 777	500
M/R Damper 758	500
M/R Damper 775	500
Flap Assembly 6-470	1000
Flap Assembly 6-479	1000
Flap Assembly 6-471	1000
Flap Assembly 6-476	1000
M/R Gear Box B18-103	240
Accessory Gear Box B19-124	500
Blower Drive Gear Box 6-88	500
Int. Gear Box B20-190	500
T/R Gear Box B21-178	500
Resolver Gear Box X82	500
M/R Hub C2-144	720
Tail Rotor Pitch Link 46A	240
T/R Pitch Link 125A	240
T/R Pitch Link 37A	240
Lead and Lay Pin M/R 74A	1000
Lead and Lay Pin M/R 76A	1000

Nomenclature	Time Between Overhaul (TBO)
Lead and Lay Pin M/R 85A	1000
Lead and Lay Pin M/R 138A	1000
Tail Rotor Rocking Pin 7A	240
T/R Rocking Pin 48A	240
T/R Rocking Pin 309	240
Retention Assembly 6-219	480
Retention Assembly A3-279	240
Retention Assembly A3-353	480
Retention Assembly A3-326	240
Rotor Brake Assembly May 61-26	500
Rotor Brake Disc 298	500
Resolver Assembly 41A	500
T/R Spider Control B-163	240
Main Drive Shaft 4A	500
T/R Drive Shaft Pillow Block 75A	500
T/R Drive Shaft Pillow Block 76A	500
T/R Drive Shaft Pillow Block 77A	500
Xmsn Oil Pump KA-49	500
Tracking Actuator 6-198	1000
Tracking Actuator 20525	240
Tracking Actuator 204129	240

Nomenclature	Time Between Overhaul (TBO)
Tracking Actuator 20490	240
Tracking Actuator 20599	240
Tube Short T/R Drive 34C	500
Tube Short T/R Drive 366	500
Tube Short T/R Drive 103C	500
Tube, Long T/R Drive 59	500
Tube, Long T/R Drive 46A	500
Tension Rod Assembly 334	600
Tension Rod Assembly 294	600
Tension Rod Assembly 328	600
Tension Rod Assembly 339	600
Retention Outboard Strap Shops 219	240
Retention Outboard Strap Shops 279	240
Retention Outboard Strap Shops 353	240
Retention Outboard Strap Shops 326	240
Tail Rotor Pitch Assembly	240
Tail Rotor Pitch Assembly	240
Tail Rotor Pitch Assembly	240
Engine 270609	400
Hydraulic Pump C3-233	500
Fuel Control 32634	800

Nomenclature	Time Between Overhaul (TBO)
Pump, Lube (Main) 1165	800
Pump, Fuel 1040	800
Pilot Valve 1135	800
Cent. Fuel Purifier 2145	800
Fuel Flow Divider 579	800
Actuator, Vane, Stator 833	800
Oil Cooler 1558	800
Anti-Icing Valve 1313	800
Speed Decreaser, Gear 270054	300
Pump, Lube Speed Dee GR103	300
Dowty Liquid Springs	500

SECTION TWO

The following is a list of malfunctions reported by flight crews, along with corrective action, man-hours expended, and echelon of repair.

Discrepancy	Corrective Action	Man-hours	Ech.	Sch.	Unsch.
Co-pilot's air speed indicator not marked.	Marked indicator.	00.05	2		x
Pilot's airspeed indicator has no slippage mark.	Put slippage mark on indicator.	00.05	2		x
Beep inoperative on both collective sticks - can beep down but not up.	Ground checked and found OK.	00.15	2		x
Beep sticks.	Replaced beep actuator.	00.40	3		x
Operational check due for replacement of beep actuator.	Checked and found OK.	00.10	2	x	
Aft navigational light burned out.	Replaced bulb.	00.10	2		x
Blade 'B' pitch lock sticks on shutdown.	Cleaned and checked; found OK.	00.15	2		x
Main rotor head lub. reg. O/D.	Completed.	00.30	2	x	
Bulb burned out aft collision light.	Replaced bulb.	00.10	2		x
Torque meters fluctuate above 55 p.s.i.	Test flown and found OK.	00.10	2		x
Pilot's windshield wiper blade deteriorated.	Replaced blade.	00.05	2		x

Discrepancy	Corrective Action	Man-hours	Ech.	Sch.	Unsch.
Folding pin torque check due.	Checked torque, found OK.	01.00	2	x	
Hydraulic pressure fitting at pump leaking.	Tightened fitting.	00.05	2		x
Pilot's clock hour hand inoperative.	Replaced clock.	00.10	2		x
Windshield wipers will not lock.	Recycled.	00.05	2		x
All main rotor outboard flap bearings removed.	Cleaned and reinstalled.	01.00	3	x	
Tail rotor pitch bearing housing air bound.	Bled air out.	00.15	3		x
Tracking motor B runs slow on inspection check.	Replaced tracking motor.	00.25	3		x
Functional test flight for removal and installation of flap bearings.	Test flown and released for flight.	00.10	2	x	
Main rotor head lube due.	Completed.	00.30	2	x	
Magnetic compass low on fluid.	Replaced compass.	00.30	2		x
Tail rotor flapping bearing inspection due.	Completed.	00.10	2	x	
Bearing removed T/R blade 337.	Replaced bearing and seal.	00.20	3	x	
Functional test flight due for installation of tail rotor bearing.	Replaced bearing and seal.	00.45	3	x	

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MILITARY POTENTIAL TEST OF THE UH-2A HELICOPTER.(U)

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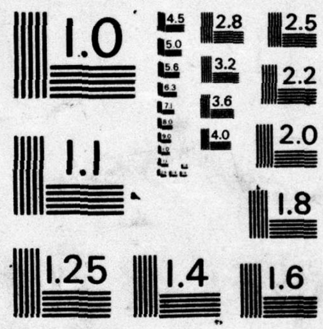


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Discrepancy	Corrective Action	Man-hours	Ech.	Sch.	Unsch.
Rotating beacon bulb burned out.	Replaced bulb.	00.10	2		x
Tail wheel lock sticks.	Cleaned.	00.05	2		x
Windshield wiper motor will not stay locked.	Replaced control valve.	01.30	2		x
UHF radio inoperative - part time.	Tightened connection.	01.35	2		x
Main rotor head lube due ten hour check.	Completed.	00.20	2	x	
Beginning of Desert Test					
Main rotor head lube check O/D.	Completed.	00.30	2	x	
UHF radio transmitter inoperative.	Replaced.	00.10	2		x
Two loud reports from engine during autorotation entry, engine oil pressure light on. Shut engine off and completed autorotation.	Trouble-shooting involved inlet inspection of stator vane, fuel control valve, and stator filter; check power turbine; operational check.	01.00	3		x
Engine removed.	Installed engine.	21.00	3		x
Torque sensing S/D/G/B removed.	Installed G/B.	(Included above)	3		x
Hoist installed.	Removed upon installation.	00.15	2		x
Ground run-up check due.	Run-up accomplished.	00.25	3	x	

Discrepancy	Corrective Action	Man-hours	Ech.	Sch.	Unsch.
Emergency actuator will not beep down.	Replaced actuator.	01.30	3		x
Throttle actuator removed.	Replaced.	(Included above)	3		x
Tail Rotor Bearing Control rod disconnected for inspection.	Inspected and reinstalled.	00.10	2	x	
Maximum power adjust required.	Adjustment completed.	00.15	3		x
Tail wheel locking pin will not seat.	Cleaned pin and checked.	00.10	2		x
Aft left hand 2-man seat removed for litter inspection.	Reinstalled seat.	00.20	2	x	
Forward left hand one-man seat removed for litter inspection.	Reinstalled seat.	00.10	2	x	
Tail wheel lock pin binding.	Cleaned.	00.10	2		x
Rotating beacon bulb burned out.	Replaced bulb.	00.10	2		x
EGT in topping 700° too high.	Adjusted 8 clicks.	00.10	3		x
Main rotor head and tail rotor lube due.	Completed.	00.30	2	x	
Removed pitch change links for air lock in tail rotor blades.	Bled air out of bearing and connected links.	00.40	3		x
Tail wheel out of rig.	Re-rigged tail wheel.	00.15	2		x

Discrepancy	Corrective Action	Man-hours	Ech.	Sch.	Unsch.
Tail wheel lock binding.	Removed burrs and cleaned.	00.10	2		x
Hair line crack on 'C' blade (#482) at joint of 2 and 3 pocket.	Repaired.	00.20	3		x
When engaging rotors rotary power control hangs up in the idle detent.	Cleaned and checked - found OK.	00.10	3		x
Starter switch will not work without wiggling power control.	Cleaned and checked - found OK.	00.10	3		x
ASE switch sticks in ON position.	Cleaned.	00.05	2		x
Fuel gauge light inoperative.	Repaired holder.	00.05	2		x
Main rotor head and tail rotor lube check due.	Completed.	00.30	2	x	
Folding pin torque check due.	Completed.	00.10	2	x	
Tail wheel will not unlock.	Re-rigged tail wheel lock.	00.25	2		x
Explosion - EGT 760° - Oil pressure '0'.	Up speed stators about 1 1/2-percent NG.	00.20	3		x
ASE will not engage.	Changed switches in cowl head.	00.30	3		x
1-1 vibration at hover.	Adjusted D blade tracking motor.	00.05	3		x

Discrepancy	Corrective Action	Man-hours	Ech.	Sch.	Unsch.
D blade tracking motor bottomed out.	Adjusted.	00.05	3		x
Main rotor and tail rotor lube and check O/D.	Completed.	00.30	2	x	
Auxiliary tanks removed.	Reinstalled.	00.25	2	x	
Dzus fastener missing on exhaust cowling station 210, left hand side.	Replaced.	00.05	2		x
Dzus fastener missing on exhaust cowling station 210, right hand side.	Replaced.	00.05	2		x
Compressor stall EGT 720° for three seconds.	Removed, re-adjusted, and installed.	15.00	4		x
Boot torn tail rotor inboard push pull rod blade 337.	Replaced.	00.05	2		x
All blade flaps removed for engineering evaluation.	Completed.	02.00	3		x
All engine cowling removed.	Reinstalled.	00.50	2		x
Functional test flight due for replacement of compressor.	Test flown and released for flight.	Flight time.	3	x	
A/C engine removed for high altitude test.	Replaced.	19.25	3		x
Speed D/G/B removed.	Replaced.	Included above.	3		x
A/C hoist installed.	Removed.	00.25	2		x

Discrepancy	Corrective Action	Man-hours	Ech.	Sch.	Unsch.
A/C battery removed.	Reinstalled.	00.15	2	x	
T/R Blade, S/N 350, removed for bad bearings.	Replaced bearings and reinstalled blade.	00.40	3		x
T/R Blade, S/N 331, removed for bad bearings.	Replaced bearings and reinstalled blade.	00.40	3		x
All main rotor controls disconnected for engineering evaluation.	Reinstalled.	02.30	3		x
Main rotor head and T/R lube due before high altitude test.	Completed.	00.30	2	x	
Rubber loose R/H landing gear fairing.	Reseated.	00.05	2		x
Engine shaft deteriorated at 200 horsepower.	Engine changed.	Included in engine change.	3		x
Master caution light flickers in flight, intermittent flashing of transfer pump and compressor caution light at cruise (not during open gear).	In flight checked OK.	Included flight check.	3		x
Autorotation r.p.m. 85%.	Flight checked OK.	Included engine change.	3		x
Functional test flight due *for removal & installation* of main rotor head flight controls and engine.	Flight checked OK - test flown and released for flight.	Flight time.	2		x

Discrepancy	Corrective Action	Man-hours	Ech.	Sch.	Unsch.
Topping check EGT 660°.	Reset and checked.	00.10	3		x
Minimum beep 95% N_2.	Reset and checked.	00.10	3		x
Auxiliary tanks reinstalled.	Flight checked OK.	00.10	2		x
ASE engage switch hard to engage.	Flight checked OK.	No time.	2		x
Bar alt. kicks off.	Flight checked OK.	No time.	2	x	
N_1 tachometer sticks.	Tachometer indicator replaced.	00.10	2		x
Hoist panel aft end loose.	Tightened.	00.10	2		x
Topping 670° EGT.	Flight checked C680, C99% N_1 on.	00.10	3		x
End of Desert Test					
Auxiliary tanks and racks removed.	Reinstalled.	00.25	2		x
ARN-21 removed.	Reinstalled.	00.10	2		x
Folding pin torque check due.	Retorqued - found OK.	00.30	2	x	
Tip cap on blade 482 dented.	Replaced with tip cap P/N K 611126-15.	00.20	3		x
Tip cap on blade 473 dented.	Replaced tip cap.	00.20	3		x

Discrepancy	Corrective Action	Man-hours	Ech.	Sch.	Unsch.
Tip cap on blade 371 dented.	Replaced tip cap.	00.20	3		x
Tip cap on blade 475 dented.	Replaced tip cap.	00.20	3		x
Main head lube and inspection due.	Completed.	00.30	2	x	
Main rotor head lube and inspection O/D.	Completed.	00.30	2	x	
No. 2 inter inspection due.	Completed.	15.45	2	x	
All outboard flap bearings removed for inspection.	Reinstalled.	00.50	3	x	
Copilot's clock inoperative.	Replaced.	00.10	2		x
Tail wheel out of rig due to temperature change.	Cleaned and re-rigged.	00.10	2		x
Test flight due for removal and installation of flap bearings.	Test flown and released for flight.	Flight time.	2	x	
TACAN inoperative.	Replaced ARN-21 with ARN-21.	00.10	2		x
Main rotor head lube and inspection O/D.	Completed.	00.45	2	x	
Battery removed for charging and reservicing.	Recharged and serviced.	00.45	3	x	
Liquid springs low.	Serviced liquid springs.	00.30	2		x
Pilots artificial horizon slower erecting than holding slight left bank.	Test flown and found OK.	Flight time.	2		x

Discrepancy	Corrective Action	Man-hours	Ech.	Sch.	Unsch.
Small holes in outboard flap attachment fairing blade S/N 475.	Repaired blade.	00.30	3		x
Small holes in outboard flap attachment fairing blade S/N 473.	Repaired blade.	00.30	3		x
Small holes in outboard flap attachment fairing blade S/N 482.	Repaired blade.	00.30	3		x
Small holes in outboard flap attachment fairing blade S/N 371.	Repaired blade.	00.30	3		x
Coning low on aircraft.	Adjusted flaps.	00.40	3		x
Checked auto track system.	Checked and found OK.	01.00	3		x
Removed lateral accelerometer.	Replaced.	00.15	3		x
Blade folding pin and retension check due.	Retorqued and checked.	00.45	2	x	
Functional test flight due.	Checked and found OK.	Flight time.	2	x	
Step to be installed for troop test.	Installed.	00.05	2	x	
ARN-21 to be removed, S/N 04935.	Removed.	00.30	2	x	
UHF inoperative.	Installed new unit S/N VD71.	00.10	2	x	
Main rotor head lube and inspection due.	Completed.	00.30	2	x	

Discrepancy	Corrective Action	Man-hours	Ech.	Sch.	Unsch.
Vertical vibration at hover.	Readjusted flap 'D' blade.	00.15	2		x
Replace 'O' ring seal speed reducer transmitter.	Replaced 'O' ring.	00.10	3	x	
T/R blade 331 flap bearing binding.	Replaced bearing P/N K101044-13.	00.15	3		x
T/R blade 331 rocking pin worn excessively.	Replaced pin S/N 34C with S/N 157C.	00.10	3		x
T/R blade 350 flap bearing binding.	Replaced bearing P/N K101044-13	00.15	3		x
T/R blade 350 rocking pin worn excessively.	Replaced pin S/N 7A with S/N 1200C	00.10	3		x
Lower conings are turned for autorotation - r.p.m. too high.	Lowered, cleaned, and installed rod ends.	00.30	3		x
Feedback crank bearing - rough retention S/N 353	Replaced feedback crank K659143-7.	01.15	4		x
Feedback crank bearing - rough retention S/N 326.	Replaced feedback crank K659143-7.	01.15	4		x

SECTION THREE

Following is a listing of parts consumed by the UH-2A aircraft during test.

Nomenclature	Part Number	Qty	Ech
Navigational Bulb	GE 1683	2	2
Beeper Motor Actuator	525520-1	1	3
Rotating Beacon Bulb	A7079B-24	1	2
Windshield Wiper Blade	XW20403-H90-20	1	2
Clock, Aircraft	A13A	1	2
Tracking Actuator	RD12-16-3	1	2
T/R Flapping Bearing	K101044-13	1	3
T/R Collar Assy	K616131-1	2	3
Rotating Beacon Bulb	A7079B-24	1	2
Windshield Speed Control	XW20690M28-14A	1	2
ARC 52 Radio	RT332/ARC52	1	2
Engine	T-58-GE-8B	1	3
Speed Decreaser G/B	37R600186G2	1	3
Standby Compass	AN5766T4	1	3
Engine	T-58-GE-8B	2	3
Speed Decreaser G/B	37R600186G2	2	3
T/R Flapping Bearing	K101044-13	2	3

Nomenclature	Part Number	Qty	Ech
Rotating Beacon Bulbs	A7079B-24	2	2
Tip Caps	K611126-15	4	3
Accelerometer	1278-5	1	3
T/R Flapping Bearing	K101044-13	4	3
Rocking Pin	K616205-13	2	3
Azimuth Assy	K660008-9	1	3
Control Rod	K659027-5	1	3
Link Assy	K659167-3	1	3
Feedback Crank	K659143-7	2	3
Tach Ind N_1	8DJ81CAA1	1	2
L Crank	K659187-9	1	3
T/W Locking Pin Head	K611678-3	1	2
Flap Bearings	K615105-11	2	3

SECTION FOUR

UH-2 Special Tools

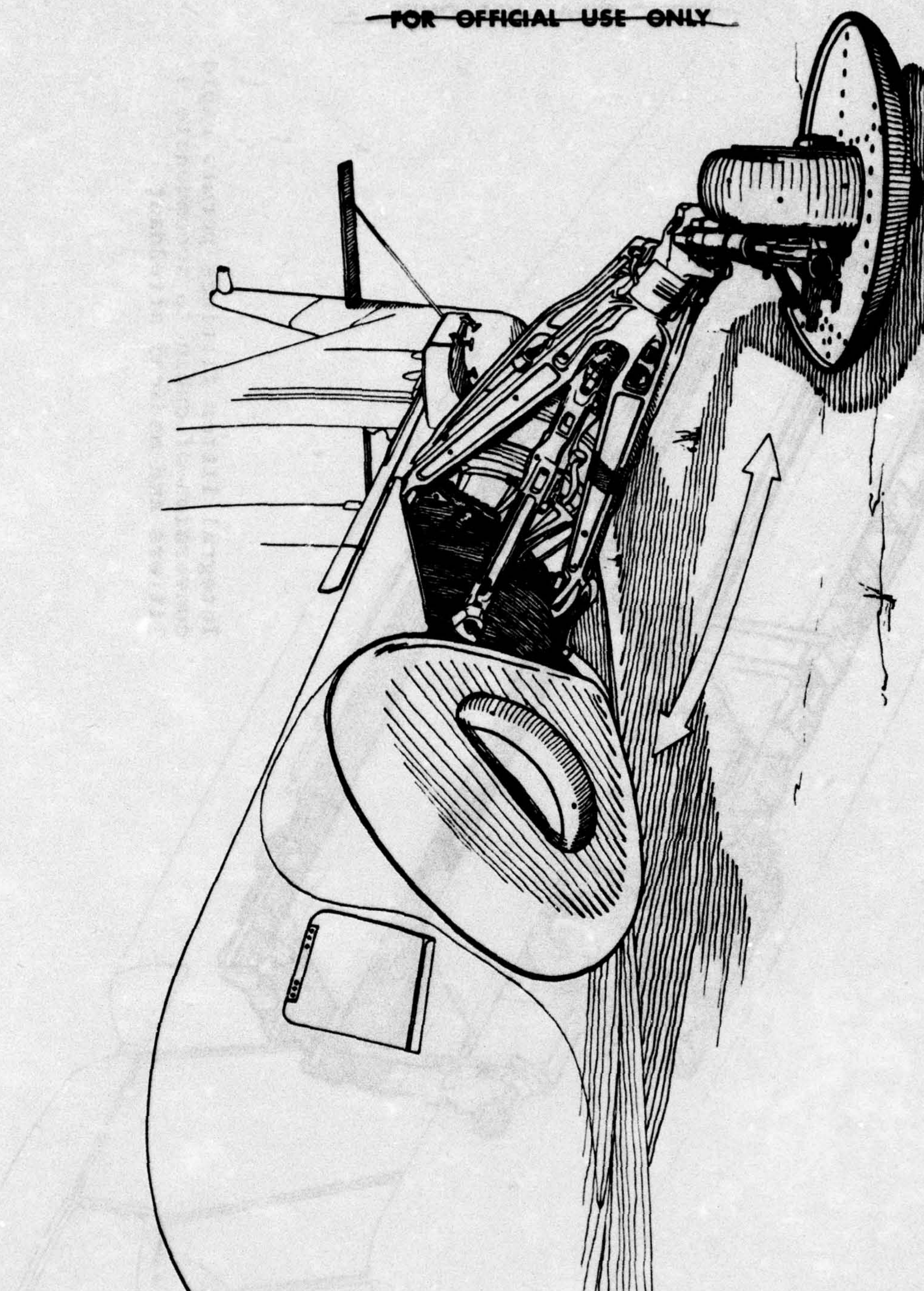
FSN	KAC Part No.	Nomenclature
RM1730-717-7314-SKAT	K604013-1	Hoist Assy, Blade, Eng, Xmsn
RD1730-064-0180-SKAT	K604014-7	Sling Assy, Blade Removal & Assy
RM1730-831-2724-SKAT	K604026-1	Shield Assy, Protractor
RM1560-772-9370-SKAT	K604017-1	Cover Hub
RM1560-772-2036-SKAT	K604019-1	Cover Cabin
RM1560-772-2037-SKAT	K604022-1	Cover Tail Rotor
RD4920-971-9035-SKAT	K604219-1	Set, Install & Remove Carbon Seals M/GB
RM1730-805-7615-SKAT	K604010-1	Hoist Adapter Assy
RM4920-794-7919-SKAT	K604351-3	Socket Assy, Nut Flanger Main D/S
RM4920-794-8072-SKAT	K604352-1	Socket Assy, Engine D/S Nut
RM4920-983-2972-SKAT	K604356-1	Plate Holding - Zurn Coupling
	K604403-101	Set, Protractor T/R Rigging
	K604404-101	Kit, Retaining Assy, Teflow Ring T/R
RX5280-980-7669-SKAT	K604503-101	Set, Alignment Drive Shafts
RD5120-795-3853-SKAT	K604510-1	Wrench, Adjusting R
RD5220-875-5041-SKAT	K604511-1	Protractor, Power Control

FSN	KAC Part No.	Nomenclature
RM4920-555-0715-SKAT	K604512-1	Fixture Install, Adapter M/R G/Box
RM1209-977-3316 SKAT	K604513-1	Wrench Assy, Fuel Control
RH4920-819-4959-SKAT	K604605-2	Test Set - ASE Flight Line
RH4920-732-2100-SKAT	K604611-1	Set - Rigging ASE Control Actuator
RD4920-343-8043-SKAT	K604616-3	Test Set Cockpit (IFT)
RM5220-885-9380-SKAT	X604701-101	Flap to Blade - Kit Protractor
RM4920-894-5188-SKAT	K604704-101	Lock Assy Rigging Pitch Control
RD4920-831-2717-SKAT	K604705-3	Lock Assy, Rigging (L Crank)
RM5120-885-9381-SKAT	K604712-9	Puller Assy, Flap Bearing
	K604713-3	Socket Assy, Nut Folding Pin
RM4920-787-3957-SKAT	K604722-101	Set Torquing Lag Pin Stretch
RD4950-590-5589-SKAT	K604724-3	Puller Assy
RD4920-971-9034-SKAT	K604733-1	Puller-Blade Folding Pin
343-8045-SKAT	K604801-5	Fixture Rigging
R 1730-772-2045-SKAT	K604805-1	Set - Rigging Tools
RM4920-554-8300-SKAT	K604714-5	Lock Assy - Rigging Control Crank
RD4920-894-5194-SKAT	K604718-1	Spacer Assy - Lag Angle
RM4920-971-0172-SKAT	K604734-1	Guide Assy - Shim Retention

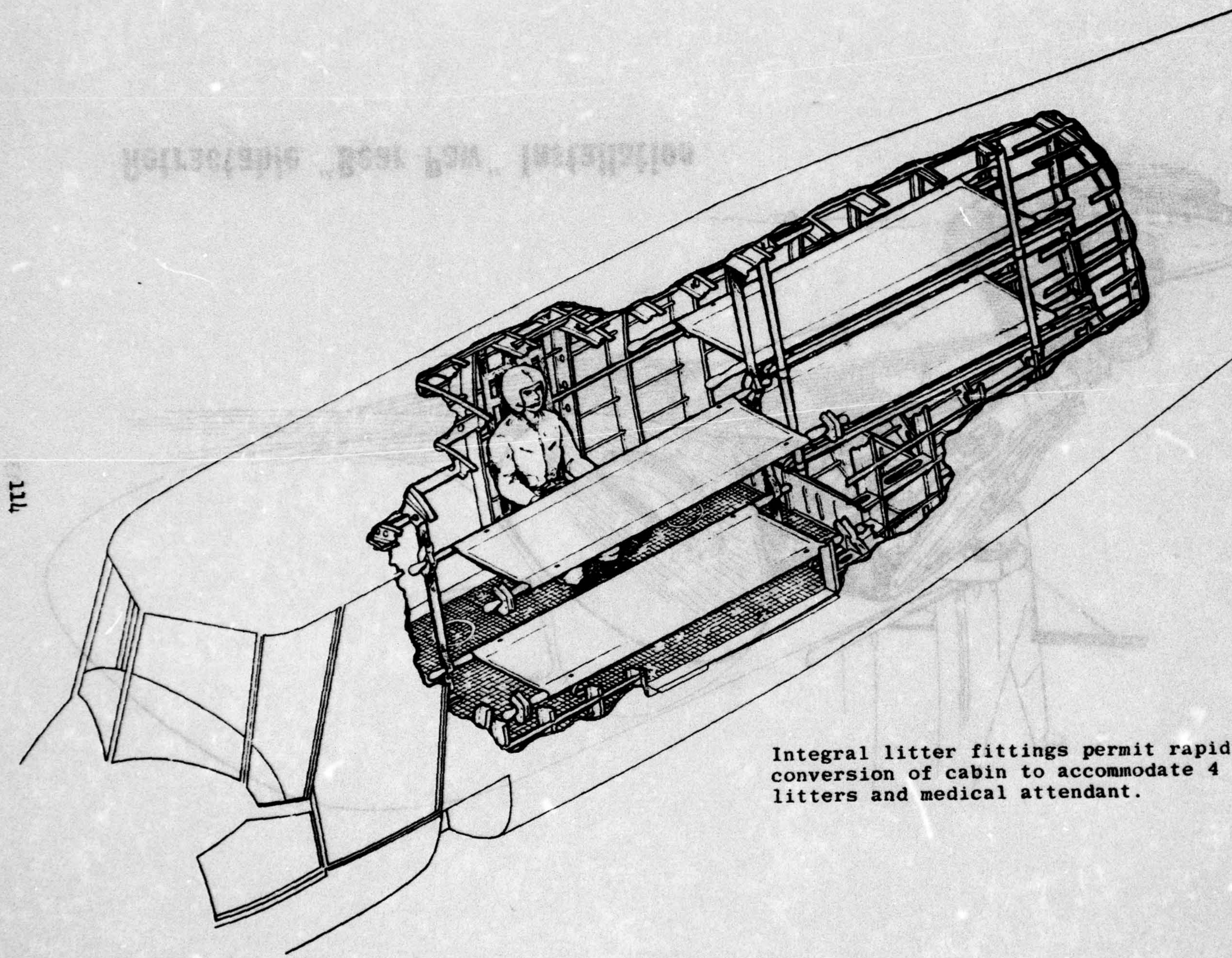
FSN	KAC Part No.	Nomenclature
RM4920-894-5187-SKAT	K604816-7	Azimuth Flatness
	K604802-201	Kit Rig Cyclic
	K604205-3	Socket
	K604304-15	Socket
R 1730-885-9379-SKAT	K604018-3	Cover, Blade
R 4730-829-5641-SKAT	K604214-1	Adapter, Trans Lifting
R 4920-831-2718-SKAT	K604215-1	Jack Screw Assy
R 5120-775-4315-SKAT	K604354-1	Adapter Socket
R 4920-863-6647-SKAT	K604355-3	Bar, Holding Z Coupling
	K604501-203	Sling Assy, Engine
R 1730-829-9009	K604735-1	Flag Assy Tracking
RD4920-083-1474-S110	1017B1020	Gun Charging

APPENDIX G

Drawings of the Retractable "Bear Paw" Installation
and Cutaway of the Cabin in a Litter Configuration.



Retractable "Bear Paw" Installation



Integral litter fittings permit rapid conversion of cabin to accommodate 4 litters and medical attendant.

APPENDIX H

LIST OF REFERENCES

1. Disposition Form, CDCMR-O, "Proposed Qualitative Material Requirement (QMR) for High-Speed Helicopter Weapons Systems (HSHWS)," (U), with one inclosure, 7 February 1963.

2. Memorandum for Transportation Corps Technical Committee, TCAFU-T, Record and Information, TCTC Item 3921, Meeting 138, Hq., DA, Office, Chief of Transportation, subject: "Utility Tactical Transport Hel (U), USCONARC Approved Military Characteristics," 20 December 1961.

3. Message 4-2275, AMCRO-DE-MO-A, Commanding General, US Army Materiel Command, 26 April 1963.

4. Letter, AMSTE-BG, US Army Test and Evaluation Command, subject: "Directive for Military Potential Test of the UH-2A Aircraft," 16 July 1963.

5. Detail Specification for Model HU2K-1 Helicopter, Class HU, Utility, Single Turbine Engine, Fiscal Year 1962, Department of the Navy, Bureau of Naval Weapons, dated 13 September 1961.

6. Report Nr. 1, Final Report, Fleet Introduction Training Program: UH-2A Helicopter, by US Naval Air Test Center, Patuxent River, Maryland, dated 24 January 1963.

7. Report Nr. 1, Final Report, Climatic Laboratory Environmental Test of the Model UH-2A Helicopter, by US Naval Air Test Center, Patuxent River, Maryland, dated 23 April 1963.

8. Flight Manual, Navy Models, UH-2A/UH-2B (HU2K-1) Helicopters (NAVWEPS 01-260HCA-1), dated 1 June 1963.

AD____________________ Accession No. ____________________

US Army Aviation Test Board, Fort Rucker, Alabama. Military Potential Test of the UH-2A Helicopter. Final report, 25 October 1963. USATECOM Project No. 4-3-3171-01. 115 pp., 17 illus. Unclassified report. Tests were conducted to determine operational performance of the UH-2A Helicopter and T58-GE-8B engine in the Army environment. It was concluded that acceptance of a relatively complex UH-2A Helicopter in the Army inventory would defeat the intent and purpose of the Army program for a low cost, easy-to-maintain helicopter, and would result in an expensive modification program and in an increased cost of maintenance up-keep in exchange for a very modest increase in performance over present utility/tactical transport helicopters; that the UH-2A Helicopter is unsuitable for Army use as a utility/tactical transport helicopter; that modification of the UH-2A Helicopter to a suitable configuration for use as an Army utility/tactical transport is impracticable because of the total number of deficiencies and shortcomings found in its physical characteristics, configuration, and mission capability; and that the T58-GE-8B gas turbine engine is unsuitable for Army use because of its demonstrated operational deficiencies in the desert environment.

AD____________________ Accession No. ____________________

US Army Aviation Test Board, Fort Rucker, Alabama. Military Potential Test of the UH-2A Helicopter. Final report, 25 October 1963. USATECOM Project No. 4-3-3171-01. 115 pp., 17 illus. Unclassified report. Tests were conducted to determine operational performance of the UH-2A Helicopter and T58-GE-8B engine in the Army environment. It was concluded that acceptance of a relatively complex UH-2A Helicopter in the Army inventory would defeat the intent and purpose of the Army program for a low cost, easy-to-maintain helicopter, and would result in an expensive modification program and in an increased cost of maintenance up-keep in exchange for a very modest increase in performance over present utility/tactical transport helicopters; that the UH-2A Helicopter is unsuitable for Army use as a utility/tactical transport helicopter; that modification of the UH-2A Helicopter to a suitable configuration for use as an Army utility/tactical transport is impracticable because of the total number of deficiencies and shortcomings found in its physical characteristics, configuration, and mission capability; and that the T58-GE-8B gas turbine engine is unsuitable for Army use because of its demonstrated operational deficiencies in the desert environment.

116